MODERN METHODS

OR

THE ART OF TEACHING

VOL III.

LESSONS IN NATURAL HISTORY.

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SPONGES.

A.—Four-Branched Sponge. B.—Gelatine Sponge. C.—Glass Sponge. D.—Six-Rayed Glass Sponge. E.—Horn Sponge. F.—Chalk-Sponge. G.—Another form of Chalk-Sponge. H.—Vase or Fig Sponge. I.—Sycometra Ciliata—another form of Chalk Sponge. K.—Cork Sponge. L.—Cork Sponge (from the Side.) M. Another class of Gelatine Sponge.

MODERN METHODS

OR;

THE ART OF TEACHING.

VOL. III.—NATURAL HISTORY.

NOTES OF LESSON ON

THE SPONGE.

SUGGESTIONS TO THE TEACHER.

[Sponge is so common an article that a piece can easily be procured to exhibit in addition to the pictures. As an introduction show the general differences between animals and plants as indicated by what follows. Only the most obvious distinction of course].

IF you prick a cat with a pin it is apt to give evidence of pain, because it possesses feeling or, as we say, sensation.

If you prick a tree or similar object it shows no feeling. The tree has no sensation. If you place the cat in one corner of a room and go away and after a time return, you will very likely find her in another part of the room or at least in some other position, and if you watch her you may see her get up and stretch herself, and perhaps come toward you. In other words, she can move because she wants to. We say she has the power of voluntary motion. On the other hand, a tree or a potted plant, having no power of voluntary motion, remains any length of time where it is put. Again the cat takes her food into an opening in the body provided for the purpose, called the mouth, and takes some of it in solid pieces; while a tree shows no such opening and is unable to take in anything in pieces even when these are very small. We might put these things together and say that

AN ANIMAL	*has sensation* *voluntary motion* *food-opening (mouth)* *and takes much food in solid pieces.*	A PLANT	*has no sensation* *no voluntary motion* *no food-opening* *and can take no solid food.*

But while these things are true of most animals and most plants they are not true of all. Let us now examine the sponge.

It does not look like any plant or any animal with which we are acquainted, but so far as we can tell it may be either. If I tell you that it grew

fast to a stone or some other object at the bottom of the water you will say it is most like a plant because it cannot move when it wants to. So indeed it was once thought to be. But before it was taken from the water it was covered all over with a layer of slime something like the white of an egg, only that it was of a very dark color. This was the living part proper and formed the thing we now call the sponge. This slime had the power of feeding on solid particles and for this and some other reasons not easy to give (although it had no sensation and could not move from place to place) it is more like an animal than like a plant, although very different from such an animal as the cat. So we see that it is not always so easy to tell an animal from a plant as it seems to be.

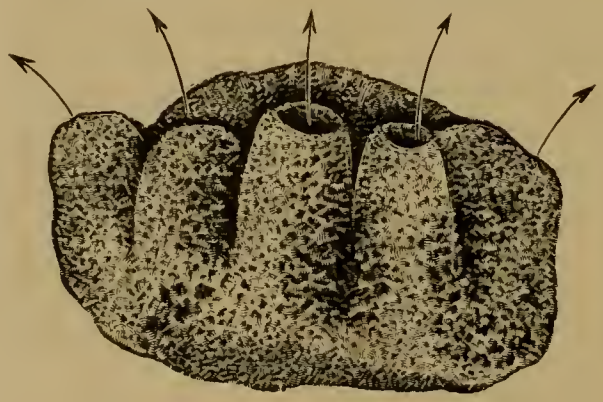


Fig. 1.

Fig. 2

The living part of this sponge is now gone, we will look at what might be called its skeleton. You find all over it a great many very small openings closely set, which run down into the sponge. There is also a smaller number of larger openings closely set, which pass into the sponge in a similar way and both sets of openings connect inside the sponge. The very small ones are called pores and because they are always present in great numbers the sponges are called by zoölogists Pore-bearers, although they use a different form of the word to say the same thing. They call them Porifera. These pores are very like mouths and while the sponge lives, a tiny stream of water is constantly made to pass into each one of them by certain motions of the sponge itself, and with the water come floating in particles of solid food. In this way the sponge gets its dinner from the water, for, being unable to go after its nourishment, it makes its food come to *it*.

Through each of the larger openings a stream of water is also continually running, but in the opposite direction, that is, out of, and away from, the sponge. (Fig. 1). This stream is made up by the joining of the tiny streams which went in through the pores. A common bath sponge is not one animal like a cat, but rather a number of animals closely and inseparably joined together and all working in harmony, each resting content with what comes in its way without trying to get what comes to another. But that may be because the sponge is so low down in the world. Roughly you can sometimes tell about how many animals belong to a sponge by counting the larger openings, a single large opening and a great many small ones being considered to belong to one animal.

Kinds of Sponges.— There are many different kinds of sponges. Some of them we should

be hardly able to use as we do our ordinary kind, because the part so soft yet strong in the one may be in others hard as the bark of a tree, or like a mass of interlacing pins and needles though often exquisitely beautiful in shape and finish as in some of the "spun-glass" sponges. (See Fig. 3). One of the largest of the sponges, from its form and size known as Neptune's cup, is shown in Fig 2. This grows to a height of three or four feet. Fig. 3 shows one of the most elegant of all sponges with its delicate lace-work pattern looking as if woven of spun glass. This is known as Venus's flower-basket, and gets to be about twelve inches high. Both of these pictures show only the dead part; in life both were clothed as is our ordinary sponge with a slimy substance, but this slime is not the same color in all sponges.

Where Found.— Sponges are found nearly everywhere in the sea, except perhaps in polar waters, but always most abundantly in the warmer regions. One kind, generally greenish in color, you may, by searching carefully, even find in some rivers attached to wharves or floating timber. The sponges of commerce are found mainly in the Mediterranean and Red Seas, and in West Indian waters; the most valued being those from the Mediterranean, next from the Red Sea, and lastly those from the Bahamas and Florida, which are coarser and less durable than the others. The depth at which the marketable kinds occur is anywhere less than thirty fathoms (180 ft.) and they flourish best where the water is clear and the bottom hard.

How Obtained. — In the Mediterranean sponges are largely obtained by divers, but in the American fisheries carried on chiefly about the Bahamas and the Florida Keys, they are almost altogether gathered by hooking and dredging. The vessels engaged are small schooners, each provided with several small boats called dingies. In calm weather the dingy puts off with two men, a sculler and a "sponger." The sponger has an iron "sponge-hook" with prongs fastened to a pole eighteen to thirty-five feet long. While the sculler propels the boat the sponger hangs over its side, looking into the clear water below. When he sees a sponge he wants he raises his hook with the help of the sculler, grapples it and hauls it in.

Fig. 3.

When the dingy is full, the load is taken to the schooner, where the sponges are heaped up and left till dead.

How Prepared for Market.— When the vessel itself is full it makes for port, where the sponges are thrown into a pen called a "crawl," built for the purpose, into which the tide can enter and are left to soak for a week or so, by which time the slimy matter has partly rotted off. The rest is removed by beating with a flat stick and washing. They are then sorted into different grades and sold to the dealers. The dealers trim them, assort them once more, and put them up in bales or on strings for export. This is the usual way.

Uses.— Sponges are used for the bath and toilet, by surgeons, and for cleansing purposes generally. Also for making hats, and for stuffing mattresses and carriage cushions.

A simple black-board outline for this lesson would be as follows:

Description.
Kind.
Where found.
How gathered.
How prepared for market.
Uses.

— F. W. STAEBNER.

NOTES OF LESSON ON

SEA ANEMONE AND CORAL.

[Get a specimen of coral to show if possible. Perhaps your druggist may have a piece he would be willing to lend if you promise to be careful of it; or a friend may have a coral pin. The white kind is best if you can get it, but be thankful for the red. If you live west of the Hudson River perhaps you can get some fossil coral].

OBSERVE figure 4. What do the objects look like? Flowers, you say. If you saw them alive and from above you might even say asters. But they grow in the ocean. Watch them a little and you may see the petal-like fringes become a little longer, or shorter, or may perhaps see them entirely drawn in. A small animal may swim near, act strangely for a second and then disappear among the row of fringes. This is not a plant, you say. Let us examine it more carefully.

The petal-like parts on top you notice are arranged in a circle, the free ends pointing away from the centre of the circle, that is *radiating* from the centre. These parts can move in all directions. They can be pushed out or pulled in, and they can in a measure take hold of things. They are parts meant for a particular use. We call such parts of bodies *organs*. Organs having the form and use of these are called tentacles. In the centre of the circle which these tentacles border is an opening into which food is put by the tenacles. This must be a mouth. So our aster having a mouth and being able to eat solid food must be an animal, although it does not seem to be able to move from place to place. But while it seems to be fastened to the bottom that is only because we have not watched it long enough. Some animals like this can slowly shift position.

Names.— Those that move about are called sea anemones, while those that are really fixed to one spot are most of them known as coral polyps.

The Sea Anemone.— The sea anemone whose name, you see, suggests its flower-like appearance, belongs to a group of animals of which there are many different kinds. Compared with the sponge they have greater freedom of motion of parts of the body, and some can slowly travel

from one place to another by sliding over the bottom of the water. Most of them are single animals though often living in great numbers in one spot; but the bodies of some are closely united to the bodies of others in much the same way as the animals of the bath sponge. Sea anemones are from an eighth of an inch to over a foot in diameter. Their bodies are soft and cylindrical.

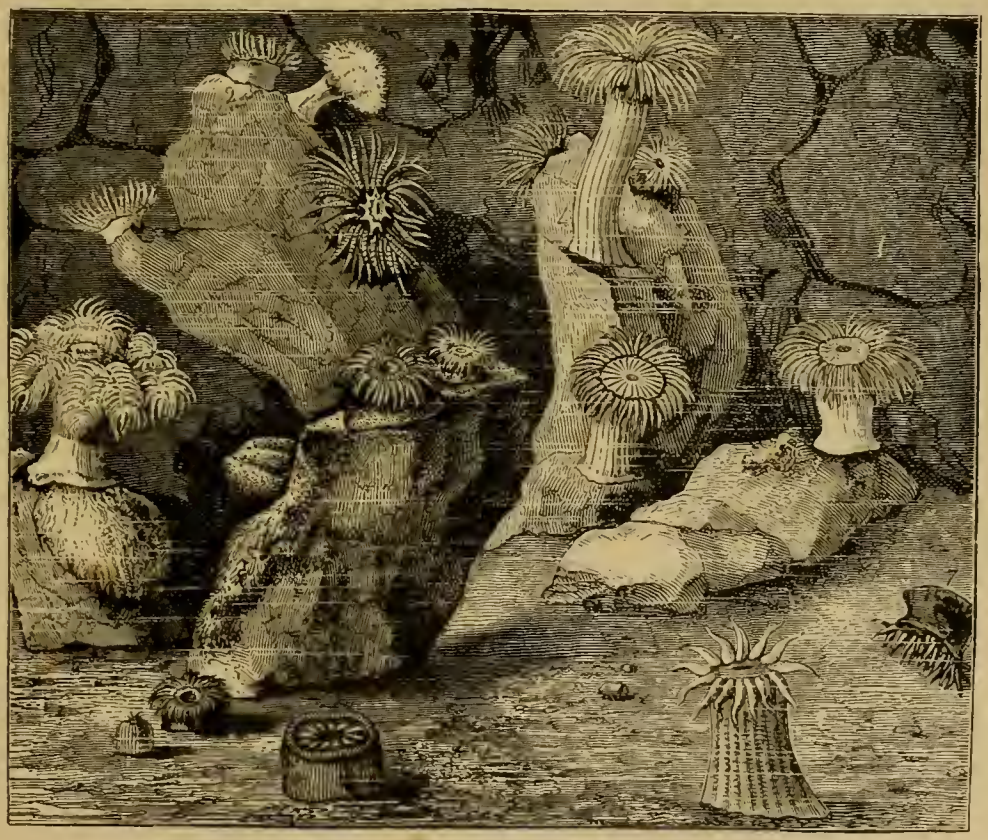


FIG. 4.—VARIOUS SPECIES OF SEA ANEMONES.

Tentacles.— At the upper end are the tentacles, which are hollow and usually gayly colored. They are in one or more rows, and sometimes number over two hundred.

Lasso-cells.— These tentacles contain minute threads which can be very quickly thrown out and have the power to sting and benumb small animals that they touch. These "stinging threads" go by the name of thread-cells or lasso-cells. They help to secure food.

Mouth.—The tentacles surround the mouth, a slit, which opens into a little bag inside the body. This bag is the stomach.

Stomach.— The stomach extends only part way down, and has a hole in the bottom, so that food can pass to other parts of the hollow body. The whole body is not unlike a bag with a smaller bag inside.

Body-partitions.— The larger bag or sack is divided off by vertical partitions which run from

its inside to the outside of the stomach in the middle of the body, something like the cells of an orange if the juicy part alone were removed. Some of these partitions run toward but do not quite reach the stomach. If we should take a slice across the body it would look like Fig. 5. The outer ring represents the cut end of the body wall, the inner ring, the stomach, and the cut ends of the partitions show as radiating lines like the spokes of a wheel.

Radiated Structure.— So the animal has what may be called a wheel-like or radiating structure. You will sometimes read descriptions in which it and other animals formed like it are called Radiates.

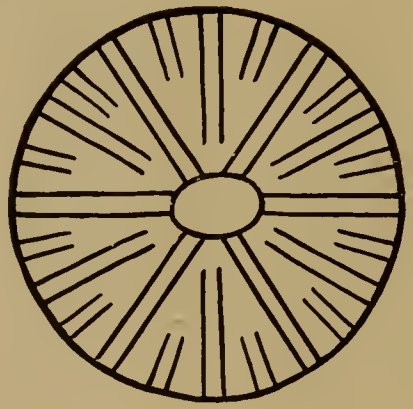


FIG. 5.

When sea-anemones die their bodies quickly decay, and, except in a few cases, nothing remains behind of these beautiful "flowers of the sea."

CORAL.

Coral Polyps.— Coral polyps closely resemble sea-anemones in shape, size and structure, but they form a stony substance that remains after the death of the polyps. This stony substance is coral.

Coral.— These polyps are not insects, as is so often stated, especially in poetry, and they do not build the coral as a wasp does its nest, but in the sense in which we do our bones. The polyps separate this substance from the sea-water in which they live; that is, they secrete it. Some polyps secrete it inside the body, and then the coral takes on the radiated structure of the animal. Other polyps secrete the coral at the base of the body, and then it does not show this structure. Red or precious coral is of the latter kind. In red coral the polyps themselves are colorless.

FIG. 6.—BRANCH OF CORAL.

Coral, like sponge, may be called the skeleton of the animals, or better a collection of skeletons, for it takes a great many polyps to make even a small piece of coral.

FIG. 7. — AN ATOLL — CORAL ISLAND.

Kinds of Coral.— Coral appears in many different forms; some kinds branch like shrubs, others are more or less rounded lumps, often of considerable size. As to color there are two chief kinds, the white (brownish before it is bleached) that we commonly see, and the red or precious coral. Only the upper parts of any growing coral are being added to by the polyps, so the branching kinds may be likened to plants in which the polyps

at the top represent the buds that will grow into new branches.

Coral Reefs and Islands.— Sea anemones and coral polyps are found nearly everywhere in the ocean but are most abundant where the water is warm throughout the year. Here in many places the polyps flourish so that they form great masses that reach almost or quite to the top of the water. Where these are near land they are called coral reefs. In parts of the Pacific Ocean, far from any continent, they come above the water, forming the beautiful coral islands. Many of these are rough circular rims of land surrounding a lake of shallow water, called the lagoon, and having the deep ocean outside. (See Fig. 7). On some of them cocoa-nut trees grow and savages live. On one coral island visited by Prof. Dana, where there were only birds, these were so tame that he could take them from the trees as if they were flowers. Usually there is a pas-

FIG. 8.— THE CHIMNEY CORAL.

sage, often deep enough to allow ships to sail through, into the lagoon. There are reefs around Florida (Florida Keys), the Bahamas and Cuba. The Caroline, Marshall, and Fiji Islands in the Pacific are some examples of coral islands. (Have the pupils, if they are old enough, find these places on the map.)

In many places on the continents and miles from the ocean are now found great masses of coral often not very different from such as is found in reefs and islands. How did it get where it now is? This is what is know as fossil coral. Iowa City is built on such a mass. At the Falls of the Ohio, near Louisville, is another such, and there are many others.

Uses.— Both red and white coral are used for ornament, but only the red has a market value, and the paler sorts of this are the more valuable. Red coral is obtained from different parts of the Mediterranean Sea, where it is dredged for. It is worked principally in Italy; an outer portion known as the "bark" being first taken off. The manufactured article comes mainly from Genoa, Naples, and Leghorn.

NOTE.—A piece of any common white coral will show the radiated structure. If your specimen is one of the ordinary branching sorts, each of the little projections scattered so thickly over the surface, is the secretion of one polyp. Note the size and number of the polyps concerned in making even a small branch. If you have one of the lumps, or "head corals," you can see the structure readily, and can also tell the size and number of the poylps, unless it be "brain coral," in which the polyps merge one into another and the skeleton does not show the work of one distinctly. In the "mushroom coral," made by a single animal, one of the largest of polyps, the radiating plates are very conspicuous. Red coral does not show this structure. Many of the fossil corals do so beautifully.

Appended are two black-board outlines of this lesson, one, of the points to be covered for older children, the other, of points for very young pupils. You can gauge the capacity of your pupils best, and will give more or less accordingly. A few headings are also added of subjects for composition. If you wish more information, and are near a library, get Dana's "Corals and Coral Islands." If you should have a recent Zoölogy, you will find corals described under the general division Coelenterates; in older books under Radiates.

BLACK-BOARD OUTLINE.

For Older Pupils.

SEA ANEMONE.

Form. Size.

Parts. { body. tentacles. lasso-cells. mouth. stomach. body-partitions.

Radiated structure.

CORAL POLYPS.

Description.

Coral. { how formed. where found. kinds.

CORAL REEFS AND ISLANDS.

Uses of coral.
Where obtained.

For Younger Pupils.

SEA ANEMONE.

Form and size.
Body.
Tentacles.
Stinging-threads.
Wheel-like structure.

CORAL POLYPS.

Description.
Coral.
Uses.

COMPOSITION.

SUBJECTS FOR OLDER PUPILS.

Describe the Sea Anemone.

Differences between Sea Anemone and the Coral Polyp.

Tentacles and lasso-cells.

Why said to have radiated Structure.

What is coral?

Describe any kind of coral you have seen.

Coral Islands and where found.

How does a polyp resemble an animal? How a plant?

SUBJECTS FOR YOUNGER PUPILS.

Tell why Sea Anemone is not a flower.

Tell how large the Sea Anemone is.

Write about the Tentacles and what they can do.

What are the stinging threads for?

Tell about coral.

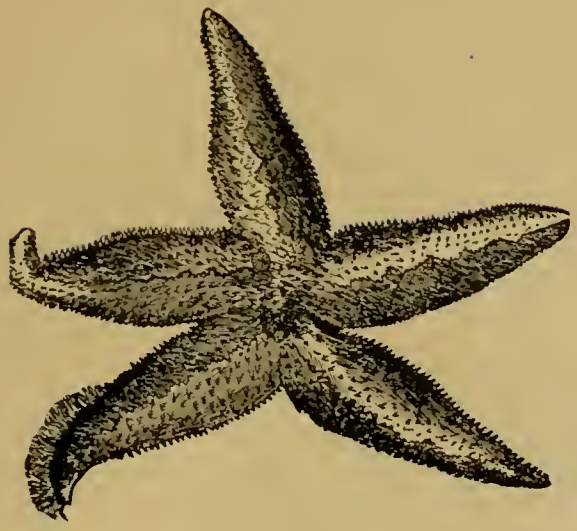


FIG. 9.

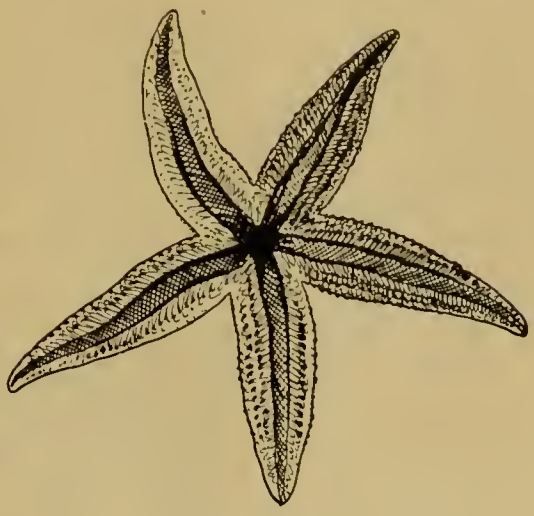


FIG. 10.

NOTES OF LESSON ON

THE STAR-FISH.

GENERAL DESCRIPTION AND NAME.

SEE the curious star-shaped object in Fig. 9. *Star-fish* is right — that is, it is commonly so called. It lives in the water, and at a time when everything that lived in the water was a fish, this was a star-fish, and so it remains to this day. (Where have you seen a similar structure? What shall we call it?) Fig. 9 shows the upper surface, Fig. 10 the under side.

Tubercles and Madreporic Tubercle. — All over the upper side are little prickles of tubercles. Just one side of the centre, in the angle between two of the branches or rays, is a tubercle somewhat different from the others, — larger, flatter, and with a rounded (convex) top, looking not unlike a wart. This little thing is called by the long name of the *madreporic tubercle* or *madreporic body*.

Grooves and Mouth. — On the under side, which is nearly flat, each of the five rays has a groove running from its tip, along its middle, to the centre of the star, in all, therefore, five of these grooves meeting at the centre, where there is an opening into the body of the animal. Into this opening the food goes. (What do you think it is?) Along the grooves, — if your specimen is large enough, has been well cleaned, and your eyesight is good, — you can see numerous very small holes. This is about all you can readily find in a dried star-fish.

Pincers. — When your star-fish was alive, it was covered all over with a thin, soft, yet toughish skin, and the rays could move in all directions. Scattered about among the tubercles, which now make up its skeleton, were a great number of little *pincers*, consisting of a stem and two prongs, which could sway about and snap open and shut, but you would need a magnifying glass to see

them well. These pincers are supposed to keep the body clean and to help the animal in getting about, by seizing hold of floating sea-weed until it can use its other organs.

Tube-Feet. — Along the grooves, in the under side of the rays, and connecting with the inside of the body through the little holes before mentioned, are four rows of little movable tubes, most of which have a sucker at the end, and can be stuck out (protruded) or pulled in (retracted) as the star-fish pleases. They show in a dried specimen that has not been cleaned as rows of shrivelled yellowish or brownish matter. With these the animal can take hold and slowly pull himself over the bottom — the common star-fish a distance of about two inches in a minute (perhaps on his way to school). Since these tubes are used as feet, we will call them *tube-feet*. Although the tube-feet are only on the under side, the star-fish when turned over on his back can, by their help, put himself right side up again. The tube-feet of one ray are connected by other tubes with those of another ray, and all are connected with the madreporic body, which seems to be a sort of sieve to let water into them.

Eye-Spots. — At the tip of each ray is a small reddish spot. It has been found that star-fish, which before moved towards the light, after the removal of these spots, though otherwise unaffected, no longer cared anything about the light, and so the spots are known as *eye-spots*.

Stomach. — The mouth opens into a thin bag inside the body, which serves as a stomach; and one of the curious things about this stomach is, that the star-fish can take it out to eat his dinner, and put it back again when he has filled it: a trick he often indulges in. From the stomach branches are given off to each ray, which is hollow.

Separation of a Ray. — Another curious thing about his starship is, that the loss of one or more of his rays does not trouble him much. He just sets to work and grows another in its place; and, stranger still, the lost ray sometimes grows others and starts out for itself in the oyster business. A single separated ray, of course, crawls about in the same way as the whole animal, and will put itself on its feet again if turned over.

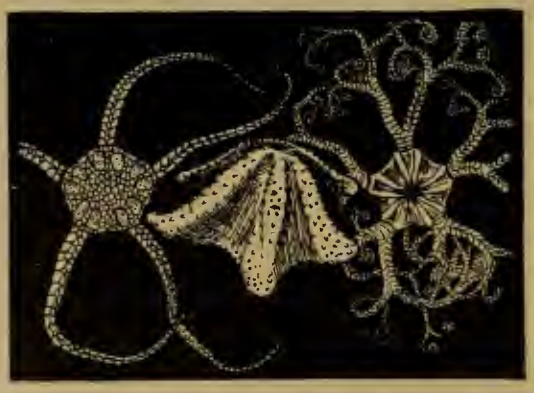


Fig. 11.

Kinds of Star-fish. — Our common star-fish is only one of a number of like animals, some of which are pictured in Fig. 11, and you can compare them with one another and with Fig. 9. The two outer ones do not have the stomach branching into the rays, and differ in other details.

Where Found. — Star-fishes of some sort are found almost everywhere in the sea. Our common one anywhere along the coast, especially in the region of the oyster beds.

Uses. — The star-fish may have uses more im-

portant to us than we know of, but he has a habit of eating oysters, of which he seems to be very fond, and so oystermen do not like him.

Suggestions to the Teacher. — A dried star-fish can be obtained from a coast-fisherman, and can often be picked up along the beach of the New England and Middle States, if you go to the sea-shore. You may be able to get one through your fish-dealer, if you live in an inland city. All these methods failing, specimens can be purchased of the Boston Society of Natural History. For further details in anatomy, consult Brooks' "Handbook of Invertebrate Zoölogy," and for interesting experiments on the living animal, see Romanes' "Jelly-fish, Star-fish, and Sea-urchins," both of which you will find in any city library. It may be a help to remember that in the books the tube-feet are called *ambulacra;* the grooves *ambulacra grooves;* the pincers *pedicellariæ*. The lower side is the *oral*, the upper the *aboral*.

Below are the outlines for the black-board for older and younger pupils, respectively, which you can modify to suit your purpose.

BLACK-BOARD OUTLINE.

STAR-FISH.

Form.

Parts —
- rays.
- tubercles and madreporic tubercle.
- pincers.
- mouth.
- grooves.
- tube-feet.
- eye-spots.
- stomach.

Kinds of Star-fish.

Where found.

Uses.

Star-fish.

Form.

Parts —
- rays.
- prickles and sieve.
- pincers.
- mouth.
- grooves.
- tube-feet.
- eyes.

Where found.

Uses.

FIG. 12.

COMPOSITION SUBJECTS.

FOR OLDER PUPILS.

1. Compare the upper and under sides of a star-fish.
2. Describe the locomotive organs as to number, form, situation.
3. Describe, from the pictures, some of the kinds of star-fish.
4. Compare the star-fish with any other fish you have seen.
5. Name the different parts of a star-fish, and tell the uses of such as you know.
6. Put together all you know about star-fish, and then tell the story of a star-fish.
7. Suppose yourself a star-fish; tell where you live and what you see and do every day.
8. Tell how the star-fish is like and how unlike the sea-anemone.

COMPOSITION SUBJECTS.

FOR YOUNGER PUPILS.

1. Tell what is on top, and what on under side of star-fish.
2. What makes the star-fish an animal?
3. Write a story telling all you know about the star-fish.
4. Tell where a star-fish's eyes, mouth, and feet are.
5. Tell why you wouldn't like to be a star-fish.

— F. W. STAEBNER.

FIG. 13.—SEA URCHINS.

NOTES OF LESSON ON

THE SEA-URCHIN.

FIG. 14.

HAVE you ever seen anything like Fig. 14? Yes, it looks quite a little like an egg, being white and rounded and brittle, and so is sometimes called a "sea-egg." But when first obtained it appears very different, having all over the outside a great number of slender little prickles or spines, and so is called a *sea-urchin*. (See opposite page).

UPPER SIDE.

Spines and Knobs.— When these *spines* are removed, as they are in Fig. 1, we find an equal number of little *knobs*. (How does it compare in this respect with a star-fish?) We can readily make out that these knobs or tubercles are in distinct rows, making five double lines radiating from the centre of the top, not unlike the ribs on a musk-melon. Between each two of these rows is a double line of smaller knobs nearer together; and there are still smaller knobs scattered all over the rest of the surface.

Madreporic Body.— Surrounding the central point of the top are five irregular pieces or plates, the largest of which corresponds to the *madreporic body* of the star-fish. (These plates are usually broken away in the cleaned sea-urchin, leaving an irregular opening.) The whole shell or, better, skeleton, is made up of very many somewhat similar pieces or *plates*, beautifully fitted together,— in an urchin of ordinary size, between five and six hundred—and when it is let fall it is very apt to break in a zig-zag line between a double row of the knobs; the zig-zag being made by the angular edges of these plates.

Tube-Feet Openings.— Along one side of each of the double rows of smaller knobs, that is, between one line of small knobs and the next row of larger knobs, is a series of very small openings, finer than pin holes, running parallel with the knobs, and, therefore, also forming radiating lines.

Turning our sea-urchin over, we find the under side rather flattish and curving inwards towards the centre, that is, concave.

Mouth and Stomach.— In this centre is an opening leading to the *stomach*, inside which is a long tube coiled up, but ending at a place nearly opposite the starting-point. (How does this stomach compare with that of the star-fish?) The opening to this stomach is, of course, the *mouth*.

Aristotle's Lantern.— In the mouth is a curious-apparatus consisting of five long and slender curved objects much like the front teeth of a rat, so arranged that the points all come together in the form of a cone, the tip of which projects a little way out of the mouth. This strange apparatus, with its supports, goes by the fanciful name of "*Aristotle's Lantern*," or simply the "lantern." There is nothing like this in any star-fish; but, it is also true, that not all kinds of sea-urchins have it.

Toward the mouth the radiating lines of knobs and pin-holes from the other side again approach one another (converge), and so the lower side of the sea-urchin looks much like the top. (Is the under side of a star-fish as much like the top?)

Like the star-fish our sea-urchin has a radiate structure, and in life, is covered with a similar thin

and leathery skin. The spines are fastened to the knobs scattered all over his outside, and can be moved in any direction.

Tube-Feet.— Through the minute holes, we noticed, come little *tube-feet* (about 2000 in an animal of average size) just as in the star-fish, but longer than the longest spines. (On what part of the body are these tube-feet situated in the star-fish?)

Pincers.— Also, as in the star-fish, there are all over the sea-urchin the little snapping *pincers*.

If we imagine a star-fish with his rays folded over his back and the spaces between filled up, we shall have something very like a sea-urchin.

Fig. 15.

KINDS OF SEA-URCHIN.

There are many different sorts, to some of which the name of "sea-egg" would hardly apply, as for instance the flattened one of Fig. 15, about as large and as thick as a silver dollar and known as a "sand-dollar" or "sand-cake." The spines also vary much in size: in the "sand-cake" they are tiny prickles, while in one form from the Indian Ocean (Fig. 16), the opposite extreme is shown. A common sea-urchin of the Mediterranean grows to the size of an infant's head.

Sea-urchins move about, mouth downward, like star-fish among rocks and sea-weed. Some live in mud, others bore holes in rocks and dwell in these. They eat sea-weed and dead animal matter.

Where Found.—Our common urchin is found along the Atlantic coast of the United States. Other forms are found in various parts of the ocean, mainly in the warmer regions.

Uses.—On the Mediterranean shores, especially of France and Italy, the large urchin mentioned above is an article of food.

BLACK-BOARD OUTLINE.

SEA-URCHIN.

Form { Upper side. / Under side.

Spines	Knobs in rows.
Madreporic body.	Body plates.
Tube-feet openings.	Mouth and stomach.
"Aristotle's lantern."	Pincers and tube-feet.
Kinds of Sea-urchin.	Where found. Use.

Fig. 16.

For younger pupils a similar outline with omission of "Aristotle's lantern." Subjects for composition will be suggested by the preceding lesson on star-fish, to which comparisons between the two forms might be added.

Specimens may be obtained from sources for star-fish mentioned in a previous lesson. To older pupils the limy (calcareous) nature of the "shell" and its similarity in this respect to a common egg-shell may be shown by putting on each in turn a drop of muriatic acid (from an apothecary's), and observing the bubbling (effervescence) that takes place. (Be careful not to get the acid on your clothes).

For further details of structure see Brooks' *Invertebrate Zoology;* for interesting experiments on motion and senses, Romanes' *Jelly fish, Star-fish,* and *Sea-urchins.* Both Star fish and Sea-urchins were formerly placed among Radiates; that group has now been separated, such members of it as have the stomach communicating directly with the body cavity (sea-anemone, etc.), forming the division *Cœlenterates* or *Cœlenterata;* those in which the stomach is cut off from such communication forming the group *Echinoderms* (*Echinodermata*). Star-fishes and sea-urchins fall in the latter division.

NOTES OF LESSON ON

THE EARTH-WORM.

FIG. 1.

"ONLY a worm!" But even a worm may teach us something. Let us see what we can find out by looking at him.

Form. — We can see that the soft body is long, cylindrical, and tapers at each end. One end is somewhat slenderer than the other. (Fig. 1).

Head-end. — This is the forward or *head-end*. (Is there any distinct head?) The other, of course, is the tail-end. In the full-grown worm toward this head-end, that is, nearer it than the other, is a thickened whitish part called the *girdle* or *saddle*.

Body-rings. — The whole body is made up of ring-like joints, and such a structure is called jointed, or *articulated*, which means about the same thing. Of these *body-rings* or ring-like joints there may be as many as three hundred and fifty. (Are they all alike in size?)

Locomotive Bristles. — Each of these rings has on its under side (that part which forms the under side of the worm) very small spines or bristles, — too small to be easily seen by the eye, but they can be felt as little points by drawing a worm backward over the fore-finger. The bristles help the worm to move over the ground, simply by preventing it from slipping. We may call them *locomotive-bristles*. (Are they more or less useful than the tube-feet of the star-fish or sea-urchin?)

Mouth and Food-tubes. — On the under side of the first ring (counting from the forward end) is a hole into which the food goes.

Looking again at the living animal notice the pearly shine of the skin and through it a dark line (sometimes faint) running along the middle, the whole length of the body. This dark line is a tube, which traced to the forward end turns out to be the opening into which the food goes. Traced the other way it ends in an opening in the last body-ring. This tube is the *food-tube*, and in it there is generally earth. (Why does it look like a dark line on the body?)

"Blood-tube."—Immediately above the food-tube, joined to it and following its course is a thinner *red* line, which is also a tube containing a red liquid. This we may call the "blood-tube," though it is not certain that this red liquid corresponds to the blood of other animals.

SPECIAL SENSES, FOOD, HABITS.

Facts to be Told. — The earth-worm has no eyes, so, of course, cannot see objects; but the head-end can distinguish light from darkness. The sense of touch is acute.

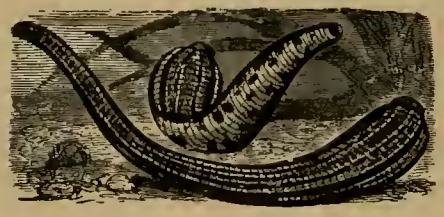
Earth-worms eat meat, fresh and partly decayed leaves of nearly all kinds, and dirt, — the last for the particles of vegetable matter in it. The great naturalist Darwin found that they have preferences in the matter of food. Some worms which he kept in pots of earth and fed with leaves of cab-

EARTH-WORMS.

bage, horse-radish, and onion at once always ate the onion leaves first. When he fed cabbage, lime, parsnip and celery leaves together, the celery was first eaten; and when he tried leaves of turnip, beet, celery, wild cherry, and carrots, the worms every time ate the wild cherry and carrot leaves before the celery, from which he concluded that they have some taste as to their food, and that all leaves do not taste alike to them.

They breathe through their skin and need some moisture in the air or in their surroundings.

They dig their way into the ground to a depth of six feet or a little more, and remain in their



THE MEDICINAL LEECH.

holes all day, coming out only at night unless forced out. The little twisted lumps of earth ("eastings," as they are called), so often seen on top of the ground and in the garden walks in the morning, are left by the worms, being the remains of the dirt eaten by them.

Kinds of Worms. — Our earth-worm, or angle-worm, is only one of the worms, of which there are a great many. The leech, still used by physicians, is a worm, but the caterpillar is not a worm. Pond-leeches and hair-worms are known to most country boys; and the tape-worm and trichina are worms you may have heard of.

THE LUG-WORM.

Where Found? —Earth-worms are abundant all over the world in damp soil. Leeches and some other worms occur in fresh water. Many worms are found in the sea; and still others, more or less dangerous, live in the bodies of other animals.

Uses.— Earth-worms may be good to bait fish-hooks with, but they are far more useful to loosen the soil so that plants may grow, and they not only loosen it but help make it. They may occasionally injure crops, but so does the rain and who would want to do without that? They also furnish food to man as well as birds, being eaten by some tribes of Indians.

For the preceding lesson the black-board outline might be as follows, cutting it down at your discretion for young pupils.

BLACK-BOARD OUTLINE.

THE EARTH-WORM.

Form.

Parts.
- head-end, tail-end, (saddle),
- body-rings,
- locomotive bristles,
- mouth,
- food-tube,
- " blood-tube."

Food, habits.
Kinds of worms.
Where found.
Uses.

Live worms can be collected by digging for them in damp earth when the ground is unfrozen, at which time they can also be found under almost any board or stone that has lain for some time in contact with the ground. (The boys will be glad to get them for you). Little children will not be afraid of them and the repugnance of older ones can soon be overcome if you act as if you were not in mortal terror yourself, and by reflecting a moment you will see that they can do you no injury. They are not poisonous and they have no teeth. For temporary observation they can be placed on plates or saucers previously rinsed in cold water and left wet. They can be kept easily in tin-boxes with holes in the cover and containing moist earth.

COMPOSITIONS.

If you can persuade any of the pupils to observe them out of school hours they might make the following easy, original observations, which would be excellent subjects for composition, or which, as a special honor, they could be called up to tell the rest of the school.

1. How does the earth-worm crawl, and can he crawl backward as well as forward?
2. What happens to the body-rings when he stretches himself?
3. How many body-rings has an earth-worm?

" *What I know about earth-worms* " would be a subject for the school, letting them write what they remember of the lesson with due regard to construction of sentences, spelling, punctuation, etc.; or a comparison of the earth-worm with any one or all of the animals of the previous lesson.

NOTE.— For interesting facts concerning the habits and work of earth-worms see "Darwin's Vegetable Mould and Earth-worms." —F. W. STAEBNER.

In the sun, the moon, the sky;
On the mountains, wild and high;
In the thunder, in the rain
In the grove, the wood, the plain;
In the little birds that sing,—
God is seen in everything.

The worm that crawls along the ground,
God made of use to man;
So we, though low our station be,
Must do what e'er we can.

There's not a leaf within the bower,
There's not a bird upon the tree.
There's not a dew-drop on the flower,
But bears the impress, Lord, of Thee.

— MRS. AMELIA OPIE.

The bird that sings on highest wing
Builds on the ground her lowly nest;
And she that doth most sweetly sing
Sings in the shade when all things rest.
In lark and nightingale we see
What honor hath humility.

How dreary would the meadow be
In the pleasant summer light,
Suppose there wasn't a bird to sing,
And suppose the grass was white!

—ALICE CARY.

Since we should love all living things,
Around us to be found;
I'll even try to love the worm
That crawls along the ground.

NOTES OF LESSON ON

THE CLAM AND THE OYSTER.

[The salt-water round clam or quahog is taken as the illustration for this lesson merely because in my experience it has been easiest to get. If you find the long clam more accessible, or living in land the fresh-water clam, use that, but by all means have actual specimens of some sort. To show the action of the siphon in the living fresh-water animal use a shallow dish of any kind, put the specimens into it and add enough water to cover. After a period of quiet you will see the "foot" and the siphon extended. Now drop a little ink or bluing carefully near the extended siphon and watch the currents. To show this with the other clams you must of course put them into sea water.

The parts of the body are not so easy to make out when one has not already had some practice at dissection but by doing the work under water (which floats the membranes apart and so renders them more easily studied), following the description and the illustrations, no difficulty will probably be felt in making out the chief points mentioned.]

The Shell—Valves.— The most striking part of the clam is not the animal but the shell, the house in which the animal lives and so we will look at that first. When cleaned it is white, somewhat convex and consists of two equal parts which are hinged together at one side and when freshly taken from the animal these two parts can be closed by pressing them together in the hands, but on removing the pressure they again fly open.

These are the doors, or *valves*, as they are called, of the house and because there are two of them the shell is a *bi-valve*, a term used for all similar shells and also applied to the animals which make and inhabit them.

Ligament.— Examining the hinged side we notice fastened to it a dark brownish, very tough substance known as the *ligament*. When this is cut, which is not easy to do — or torn — readily done when thoroughly dry — the valves no longer fly open. This ligament then must be a sort of spring put there not to shut but to open the valves and so the shell of our clam may be likened to a house without windows but with doors intended to stay open by means of a spring. (In the so-called long clam this ligament corresponds in position and action to a piece of strong rubber put between the two parts of the hinge of an ordinary door which is compressed by the shutting of the door and forces the door open on removing the pressure. See if it holds a like position in the round clam or in the fresh-water clam.)

Lines of Growth.— Look now at the outside of either valve and notice a series of lines, parallel with the gracefully curved free edge of the valve and hence one within another (concentric). (Feel of the shell then see what it is that makes it rough). These concentric lines are *lines of growth* each one was once the edge of the shell and as the animal grew it added another and another line of matter so as to keep room for itself inside.

Muscle-scars;— Pallial Line.— Look next at the inside of a valve. Along the edge is a rather broad glossy purplish band with a slight depression at the right and another at the left. These are the *muscle-scars* and each marks the place where a muscle was fastened, the use of which was to shut the shell. (See Fig. 1).

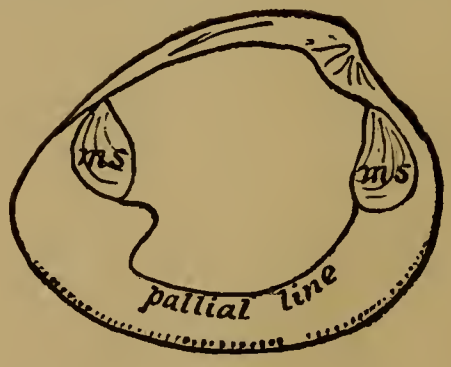


FIG. 1.

The line marking the inner edge of the purplish band is the *pallial line*; to this was attached the part of the animal called the mantle.

Inside of this line the rest of the shell is a chalky white.

Material of the Shell.— Put next a drop of muriatic acid on the shell as you did in the case of the sea-urchin and the coral and observe whether the same effect is produced. What is the material of which the shell is made?

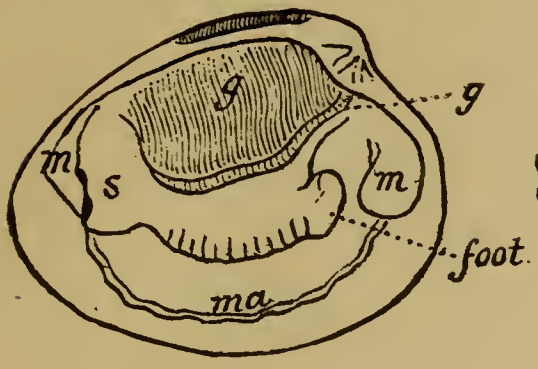


FIG. 2.— RIGHT VALVE WITH MANTLE REMOVED.

The Animal — the Mantle.— Put a live clam into hot water for a short time. Then with the aid of a strong knife you can pry open the valves and running the point of the knife carefully along the inside of one valve separate it from the animal. Lifting off the now separated valve we find a thin membrane, which lined the valve and was fastened to the pallial line. This membrane is the *mantle*, and its use is to make and repair the shell. Cutting this carefully away, we have something like Fig. 2.

Adductor Muscles — Siphon.— At each side (*m*) the cut end of the pinkish muscle which by its shortening shuts the valve. These are the *adductor muscles*, the scars of which we before noticed on the inside of the valve.

On the left side (*s*) a fleshy part, capable of considerable extension and having two openings directed toward the left. This is the *siphon*. It is much more prominent in the long clam (Fig. 3). Through the larger of the openings, water with floating bits of food is taken in by the clam and through the other opening the water is again discharged.

Gills.— At *g* are two thin folds of membrane marked with fine parallel ridges and lying one above the other. By means of these the clam breathes. Special organs for breathing the air contained in water are called gills. These are the clam's *Gills*.

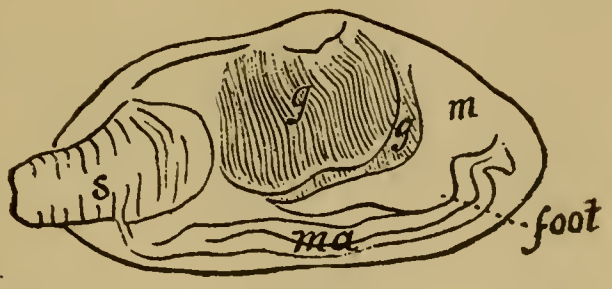


FIG. 3.

Body-"foot."— Lifting up the two gills we see the thick body of the clam, the lower right-hand portion of which can be extended out of the shell as a tongue-shaped mass, and being used to move the animal about in the sand or mud in which it lives it is called the "*foot*." Lifting up the body next we find under that two gills similar to the two already observed and beneath them, lining the still attached valve (*ma*, Fig. 2) the other part of the mantle, showing its thickened, dark-colored and ruffed outer edge.

The Oyster.— Compare now the shell of the oyster with that of the clam and note that the two valves are not alike in size, one, larger and deeper than the other, is the lower or left valve and generally bears marks on the outside of having been attached to something; the other, smaller and flatter, is of course the upper or right valve. There is but one muscle-scar, instead of two as in the clam.

Comparing the animals, notice the mantle and the gills. There is no siphon, and no foot. The dark portion toward the hinge contains the stomach and liver,— the blackish part being mainly liver. Near it is also the mouth, difficult, however, to find.

Structure.— Compared with the animals we have studied before, we notice that the clam and the oyster are not made up of ring-like parts, nor of parts radiating from a centre, but that they are soft-bodied animals enveloped in a bag-like "mantle" and inclosed in a hard, limy shell. Such animals are called Mollusks or Mollusca, and those mollusks having the thin leaf-like gills, as the oyster and clam, are known by the long name of *Lomellibranchs* which means, very nearly, leaf-gills. Because they have no distinct head they are also sometimes called in the books *Acephals*, meaning headless, but because of the two parts to the shell it may be easier to remember them simply as *bivalves*.

Kinds of Mollusks.—There are about 20,000 different kinds of Mollusks of which number about 5000 are bi-valves. The latter range from tiny shells to the giant clam Tridacna, sometimes five feet across, the shell alone weighing nearly five hundred pounds. Some are fixed permanently to one place like the oyster; others, as the clam, move slowly about, still others as the scallop, with considerable rapidity. Some bore into solid rock, others, as the so-called "ship-worm" which is not a worm, bore into wood.

Besides the oyster and clam, the pecten or scallop, and the mussel are common in the markets of our sea-port cities.

Where Found.—Bivalves, and so of course Mollusks, of some sort, are found almost everywhere in fresh and in salt water, but chiefly in the latter and as a rule in not very deep water.

Uses.— The oyster, clam, scallop, and mussel are used for food, the first especially being cultivated for this purpose. In July and August the oyster lays its eggs and the young swim about for a time after hatching before they fasten themselves to objects on the bottom. In from two to four years they are ready for market, and are gathered by being scraped from the bottom with a dredge.

The clam is also used for bait. Among other bivalves the pearl-oyster yields the valued pearls. Pearls are often formed in the common oyster, the clam, and the fresh-water clam, those from the last-named having sometimes a money value which is not true of the others. These pearls are formed by grains of sand or other particles getting between the mantle and the shell and there being covered with the substance which the mantle secretes. The shells of certain bivalves furnish us with the material called mother-of-pearl used in making buttons, knife-handles and inlaid work, while the shells of all mollusks can be, and of many are, "burned" for quicklime.

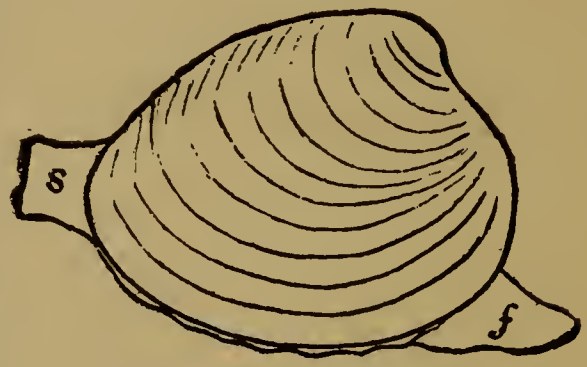


FIG. 4.—SIPHON (S) AND FOOT (F) EXTENDED.

BLACK-BOARD OUTLINE

	CLAM.	OYSTER.
The Shell.	valves.	valves
	ligament.	ligament.
	lines of growth.	lines of growth.
	muscle-scars (2).	muscle-scar.
	pallial line.	pallial line.
	material of shell.	material of shell.
The animal.	mantle.	mantle.
	adductor muscles.	adductor muscle.
	siphon.	——.
	gills.	gills.
	body.	body.
	foot.	——.
	structure.	structure.

Kinds of Mollusks. Where found. Uses.

Subjects for composition work will be suggested by the preceding lessons, which see. It will be well to have the descriptions largely comparative; the ability to recognize the same essential thing under different forms is of value to others besides naturalists, and one of the chief uses of the study of natural history after all is to open one's eyes and enable one to see things straight.

—F. W. STAEBNER.

NOTES OF LESSON ON

THE COMMON SNAIL.

The Shell and its Parts.

IN damp, shady places in the woods you will find him, carrying his house upon his back and leaving a glistening trail behind. But perhaps you have only found his empty house, so we will look at that first.

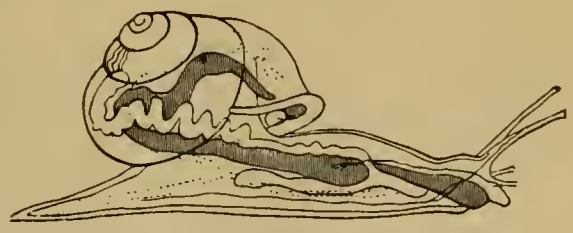
See how it is made of coils or twists (*whorls*) each whorl smaller than the one below. These whorls, together, form the *spire*, although the spire may not be very tall. To borrow from the peaceful Quakers, we might call it a "steeple-house." At the end of the largest whorl is the door-way or *aperture*.

What a delicate brown the house is colored, though if the owner has been dead some time it may be nearly white because the paint has worn off. You see the owner keeps it in repair while he is alive.

THE GARDEN SNAIL.

Observe the fine parallel lines all over the outside. (What are they parallel with?) These are the *lines of growth*. This curious house is built from the top (apex) of the spire downward by adding layer after layer around the aperture. Think of enlarging your house by extending your door-way! You can find out what the building material is by putting a drop of acid (muriatic or nitric) on it. If you notice a bubbling or foaming (*effervescence* is the word) where the acid is applied you may conclude it to be limestone — you may call it limy. (Have you ever seen objects made by creatures other than man composed of similar substance? Where?)

This limestone house is the shell of a snail and being all in one piece it is *univalve*. (Do you remember what we called the shells of the oyster and clam which are in — how many pieces?)



ANATOMY OF THE COMMON GARDEN SNAIL.

The shaded parts are the Stomach and Intestines; the single lines are Nerves; the dotted lines Blood vessels.

The Animal and his Parts.— If the owner is not at home we must find one who is. Look about in the same spot you found this for another. Leave him in quiet a while; when he thinks it safe he will come out. When he is out (he cannot come out entirely and leave his house) notice his soft, grayish body? (Has he a head? How do you know?)

At one end of his body are two pairs of little, movable fleshy stalks or "horns," one pair much longer than the other. (Which pair?) Touch one of them. How quickly they are pulled in and seem to melt into the rest of the body. These "horns" are the *tentacles* or feelers, and because they can be withdrawn, as you saw, they are *retractile*. The little black speck at the end of each longer tentacle is an *eye*.

On the under side of this end of the body is a little opening — the *mouth*. In this mouth is a tiny strip covered with minute points that serve

as *teeth*. This strip is spoken of as the "lingual ribbon" or in some books as the "odontophore"—

LINGUAL TEETH OF SNAIL (*Achatina.*)
l. l., lateral rows; c, central rows.

meaning tooth-bearer, and by its motion backward and forward, over an object, the snail files off his food. (You cannot see this well without a microscope, but you can give him a toadstool or the tender leaves of lettuce or cabbage and watch the motion in eating).

On the middle of the back and covered by the shell is the part known as the *mantle* which furnishes the material for and adds to the shell. On the right side and just under the shell is also the *breathing-hole*.

The whole under side of the body being used in moving over the ground is for that reason termed the *foot*. (Are there any other feet?) Observe how rapidly the snail moves and you will understand what is meant by a "snail's pace."

Other Snails.— There are very many kinds of snails, the smallest no larger than the head of a pin — the largest over a foot in length.

The eyes vary in position in different snails, in some being at the base of the tentacles instead of at the end. There are variations in position and size also of other parts. The shell is in some large enough to contain the whole body, while in others it may be very small or entirely wanting — these latter are known as Slugs.

When the shell is held spire upward, open end toward the person, the aperture is in some cases to the right, in others to the left. The shell is sometimes gaily colored or marked with ridges.

SNAILS AND SLUGS.

Where Found.— Snails are found in all parts of the world, in moist places on land, in rivers and ponds, and in the sea.

Habits.— Our common snail lives on decaying leaves and other vegetable matter, and during or just after rainy weather can be readily found crawling about in suitable situations. The young hatch from eggs which are laid in June, and come out with a tiny shell of a little more than one turn or whorl. In Autumn it creeps away and withdrawing into its shell, seals the opening by a layer of slimy mucus, which on drying forms a thin,

transparent, parchment-like membrane, behind which it rests during the winter (the naturalist says it *hibernates*) to awake again in the spring.

While many snails live on vegetation, some feed on animal substances. While some close the opening to their shells with a thin, tough skin, others fasten up with a stiff, limy door called an *operculum*.

Slugs are chiefly active at night, doing sufficient damage in the garden to be considered a nuisance. When young they are known to climb trees in search of food and occasionally let themselves down at more than a "snail's pace" by a thread of sticky mucus with which they are lavishly provided somewhat after the manner of spiders, but, unlike spiders, they cannot draw themselves up again.

Uses.— In Europe, especially France and Italy, several kinds of snails are eaten and are regularly sold in the markets for that purpose. They may sometimes be seen pictured on the sign-boards of restaurants.

The ancient Romans had snail-preserves, where these animals were raised for the table, and in the buried city of Pompeii may be seen heaps of shells, the remains of funeral feasts in the cemetery.

Our common snail is edible, as are probably many others.

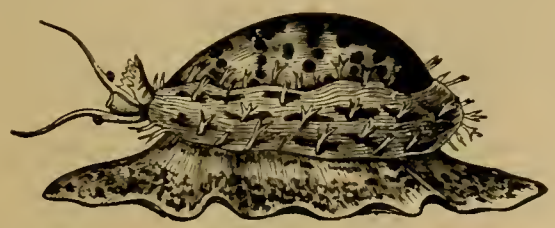
Classification.— Snails belong to the great group of soft-bodied, unjointed animals known as Mollusks, and because of the possession of a distinct head, and the use of the under surface of the body as a creeping-organ or "foot" to that section of mollusks called *Gasteropods* (literally belly-footed.) Other familiar gasteropods are the Tiger-cowries, whose shells were once so common on the parlor mantel or the what-not, Ear-shells and Cone-shells, also occasionally seen.

Suggestions.— This subject may be used as a composition exercise before being regularly given as a lesson, and again afterward.

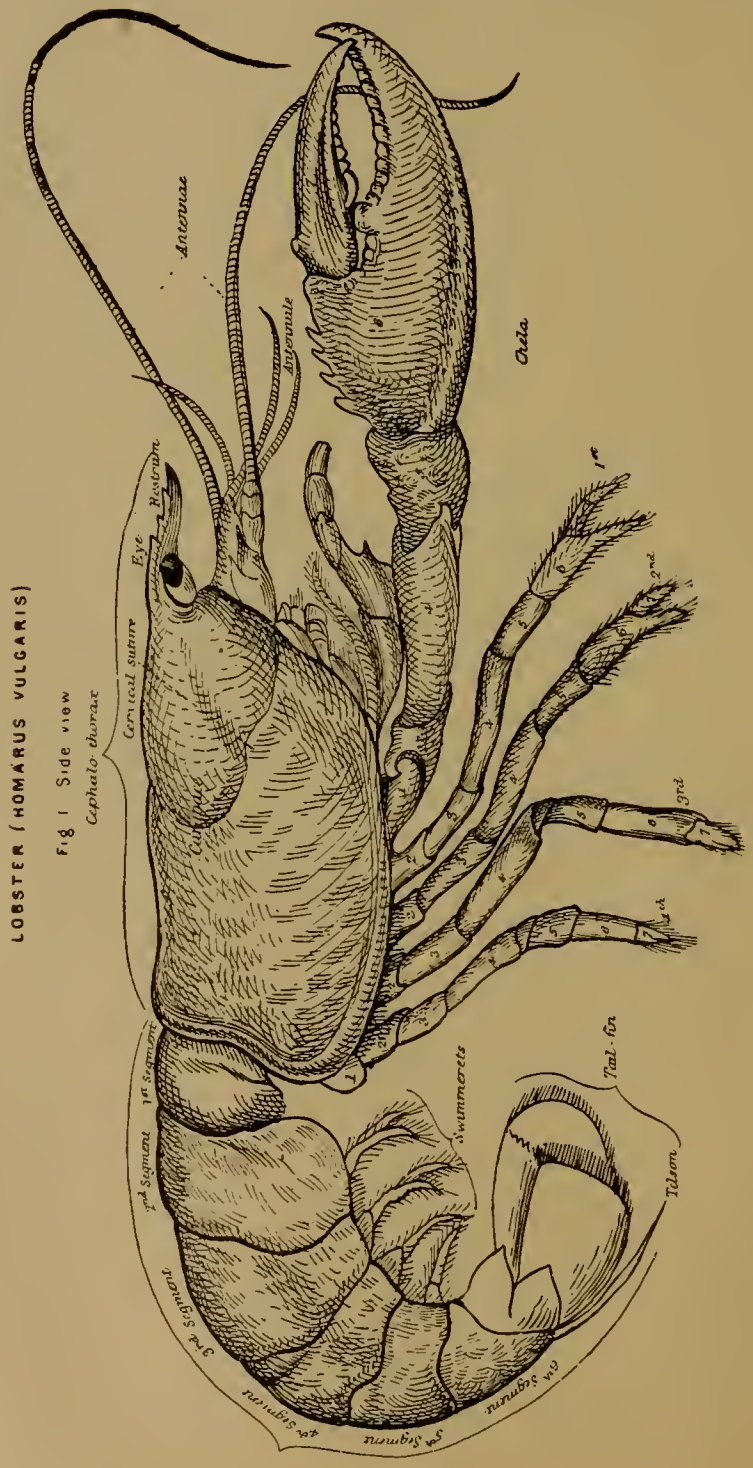
Have pupils collect land-snails by searching in damp situations among leaves, rotten logs, etc., in a hard-wood grove, preferably on a hillside; or, fresh-water snails in ponds and ditches, on the stems and leaves of aquatic plants; or, if near the sea-coast, salt-water snails at low tide on rocks or among sea-weed. Keep the land-snails in a fruit-jar with damp earth; the fresh-water kinds in a jar of water, the sea-snails in a jar of salt-water.

Beginning with the shell, the requirement may be to write out all that can be seen by simple examination, asking no questions. Next day give a lesson on the shell. Then have similar treatment of the living animals. Follow this by the lesson. Develop the lesson, of course, by questions. Where any experiment is to be performed or observation made, have the pupils make such experiment or observation. State only what they cannot discover for themselves. Now the compositions may be rewritten with the added knowledge incorporated. The pupils might also be asked to bring such ornamental shells as they may be able to obtain for written work in comparison. Finally, comparison of the snail with the oyster or the clam, with the lobster or the crab, with the ant or the bee may be made.

Further information may be gotten from Morse's admirable *First Book in Zoölogy* and from a popular article in *Scribner's Monthly* Vol. XVII, entitled: *In a Snailery*.



THE COWRY.


LOBSTER (HOMARUS VULGARIS)
Fig 1 Side view
Cephalo-thorax
Cervical sutur
Eye
Rostrum
Antennæ
Antennule
Orbit
1st
2nd
3rd
Chel
Swimmerets
Tail-fin
Telson
1st Segment
2nd Segment
3rd Segment
4th Segment
5th Segment
6th Segment

NOTES OF LESSON ON

THE LOBSTER AND THE CRAB.

I. — THE LOBSTER.

LAY the lobster back up. Its color is dark greenish or greenish-black often mottled with reddish-yellow, but varying considerably in shade; after being boiled it is bright red. Scratch the outside with a pin or your finger-nail — you find it hard. Note that the body is long and nearly cylindrical. Observe two distinct parts commonly called "head" and "tail" respectively. The "head" is all one piece, but on it is a more or less plainly-marked groove running downwards and forwards each side from the back. All in front of this line is *head* and all back of it corresponds to the separate part we call *thorax*, when studying the bee. But since head and thorax are here merely divided by a curved line we call the piece *head-thorax*, or *cephalo-thorax*, meaning just the same thing. The "tail," made up of rings, is the *abdomen*. (Figs. 1 and 3).

Head-thorax. — In the middle line of the cephalo-thorax is a sharp projection extending forward beyond the body, the rostrum or beak. On either side of this at its base is a little movable stem or stalk with a rounded black spot on its end. This black spot is an eye, made up of many smaller eyes, therefore a *compound-eye*. The stalk supporting it is an *eye-stalk*. Under the eyes is a pair of long many-jointed *feelers* or *antennæ*, and in front of the eyes a similar pair of shorter antennæ or *antennules*, but while each antennæ is a single long, whip-like object, each antennule is forked so that there seems to be a pair on each side.

Looking now a little below the antennæ in front part of head-thorax and working toward the under side of the body, Figs. 2, 3, we find a pair of hard, tooth-like nippers, opening from side to side and touching when shut. These cut the food and are the *jaws* or *mandibles*. Between them is the *mouth*. Under them are two pairs of thin flaps lying close together which help the mandibles in preparing the food; they are the *lesser jaws* or *maxillæ*. Below these we find three pairs of organs which, especially the last pair — look a little like feet and yet also help in eating. They are the *jaw feet* or *maxillipeds*. (All these parts, mandibles to maxillipeds, are so closely laid against the body and so overlap that it is perhaps easier to examine them in reverse order beginning with the maxillipeds). Now we are quite on the under side of the body and have before us a pair of jointed limbs to which the great claws or pincers (*chelæ*) are attached. Following these are four more pairs much like those just described, yet each succeeding pair differing more and more from the first, but all plainly intended for walking, that is, all but the first, which bearing the great claws is rather a pair of weapons than feet, but all five pairs are commonly called *walking-feet*.

Lifting up the overlapping edge of each side of the cephalo-thorax we find attached to the bases of the legs a series of light-colored feathery parts each consisting of a stem and fringe of soft material. These are the *breathing-organs* or *gills*.

The lobster breathes air but he gets it out of the water. If you draw a tumbler of water and set it aside in a warm room, in an hour or less you will see on the inside of the glass tiny bubbles of air which have come from the water. All water naturally contains some air. A great many animals that live in water breathe by means of gills. Perhaps you know of some.

Abdomen. — Examining the abdomen we find it made up of six quite similar ring-like pieces or segments, and a differently shaped end piece called the *telson*. On the under side of the abdomen each ring bears a pair of flattish appendages used in swimming. These are the

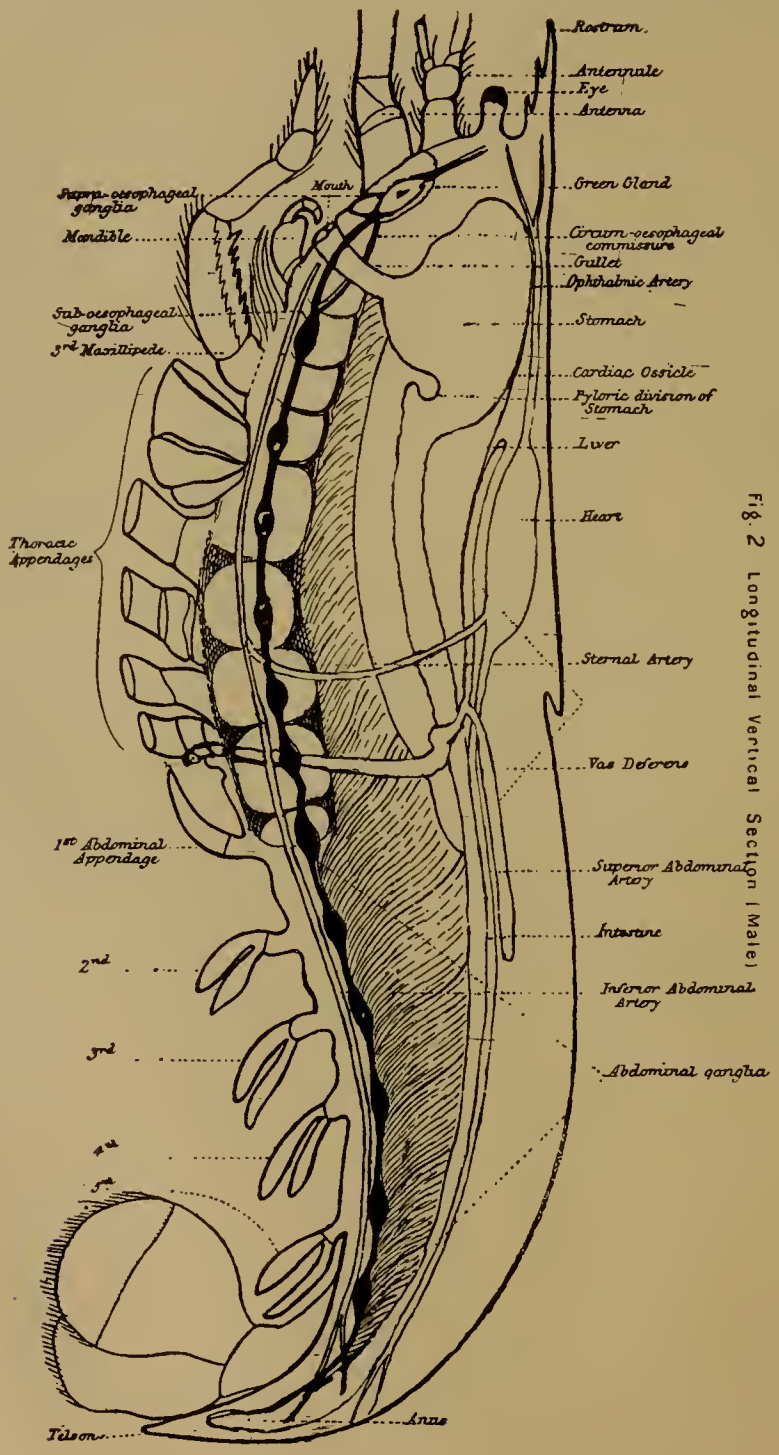


Fig. 2 Longitudinal Vertical Section (Male)

swimming-feet or *swimmerets*. The last pair of swimmerets is much larger and broader than any of the others, and each consists of two flaps which can be spread so as to form with the telson, a fan-shaped "tail-fin" with which the lobster can swim very swiftly backwards. (Fig. 3).

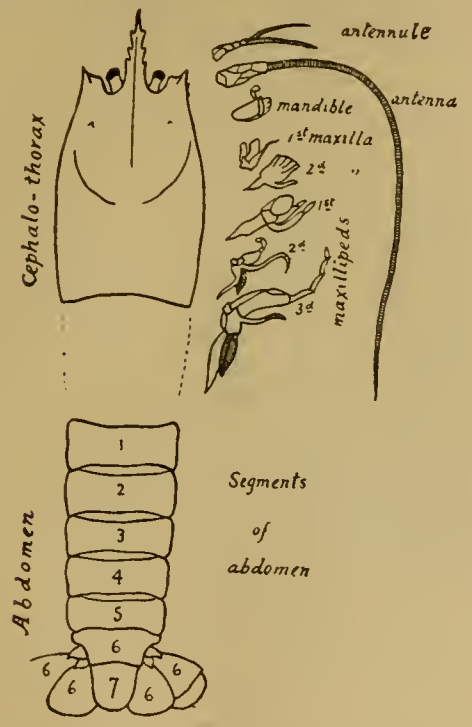


FIG. 3.

Internal Structure. — Some other curious things about the lobster you may like to know. The food torn by the jaws goes from the mouth through a short tube into the *stomach*, which is a soft bag stretched over a hard frame and contains teeth—*stomach* or *gastric-teeth*. You can readily find the stomach as it takes up the larger part of the forward end of the cephalo-thorax. (See Fig. 2). It is often called the "lady."

The *heart* lies inside the back along the middle line of the head-thorax, and forces the nearly *colorless blood* to different parts. The blood is gathered up along the under side of the body, and after passing through the gills, returns to the heart. A constant supply of water is made to wash the gills, partly by the motion of a little scoop, the *gill-bailer*, partly by the movements of the walking-feet to which we found the gills attached.

The *ear* is a little pit at the base of the antennules.

As the body of our lobster is composed of jointed pieces it belongs to the group of animals called Articulates, or, more commonly now because it also has jointed limbs, Arthropods or Arthropoda. As head and thorax are united and the whole outside is a hard crust it belongs to that division of Arthropods known as Crustacea or Crustaceans.

Where Found. — The lobster lives in the ocean near the coast, preferring rocky bottom, but also found where it is sandy or gravelly. Our lobster is common on the Atlantic coast from New Jersey northward.

Habits. — The lobster can swim rapidly backwards or forwards, and can also walk and climb under water. It eats other animals alive and dead, that is, it is carnivorous. When a limb is lost by accident another grows in its place. Lobsters hatch from eggs, which are little globular bodies, nearly black, and about as large as cabbage seeds, and which are attached in great numbers to the swimmerets of the mother chiefly in spring and early summer. As the lobster grows his hard coat gets too small for him, so at a certain time in warm weather the body loosens itself from its covering, this splits along the back, and the lobster pulls himself out. He has *moulted*. (What other animals moult?) The lobster is now soft, and to escape his enemies, who would be glad of such a tender morsel, he goes into hiding till his outside has again hardened. He moults often at first, but only once a year after he is full-grown.

Kinds of Lobsters. — There are many different kinds of lobster-like animals most of which live in the sea, but one sort lives in some rivers and lakes. This is the fresh water-lobster, crawfish or cray-fish, sometimes wrongly called crab.

— F. W STAEBNER.

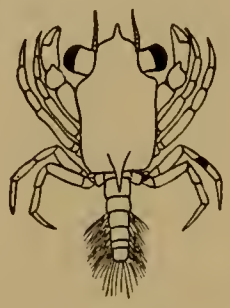


FIG. 2.—YOUNG-CRAB

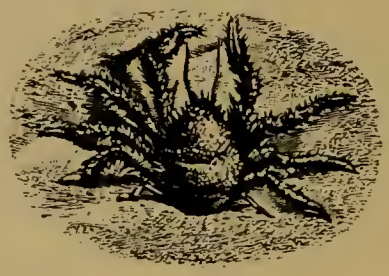


FIG. 5.—SPIDER-CRAB.

FIG. 3 —THORNBACK-CRAB

FIG. 1.—EDIBLE CRAB OF EUROPE.

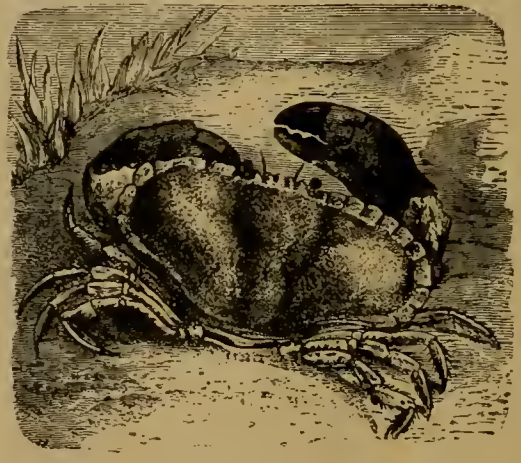


FIG. 4.—COMMON-CRAB.

NOTES OF LESSON ON

THE CRAB.—II.

THE crab at first sight looks very unlike a lobster. Holding it as in Fig. 1, we note that it is short and flattened, that its color is a dark green or bluish-green, and trying it with a thumb-nail we find it hard outside.

All the upper side is *cephalo-thorax*. Turn the crab over. Tightly pressed against the body, in a groove in which it snugly fits, is a jointed flap. Pulling it out you find it fastened at its broader end to the cephalo-thorax. This is the *abdomen*; count the number of pieces of which it consists. Then see how many of the following parts you can find.

pair	of stalked eyes	attached to cephalo-thorax.
"	" antennules	
"	" antennæ	
"	" mandibles	
2 pairs	" maxillæ	
3 "	" maxillipeds	
pair	" pincers	
4 pairs	" walking-feet	
6 "	" swimmerets	attached to abdomen.

We find the crab, although apparently so different, on the whole very much like the lobster. Animals that are like one another in structure we put together; those most alike being placed nearest together. This is called classifying. We have already classified the lobster. The crab, being like it in having the body made up of jointed pieces to which are fastened jointed appendages belongs to the same group *Arthropoda*, and because of its hard outer crust to the same division *Crustacea*.* The lobster and crab both having ten walking-feet belong to the same division of the Crustacea, the *Decapod*, or *ten-footed* Crustaceans. Again, because of its seemingly shorter abdomen or "tail," the crab and others like it are called *Short-tailed* decapod cructaceans, while the lobster is put with the *Long-tailed* division.

You must not suppose it is always easy to classify animals. Some crabs, for example, you might not know whether to call long-tailed or short-tailed. In such cases the naturalist uses his judgment and puts them with those they most resemble in other respects. If you were told to take all the books out of a case and put the large ones in one pile and all the small ones in another, you might meet with some about which you would find it difficult to decide whether they ought to be called large or small, so you would have to use your judgment and put them with the pile they most resembled. Some one else might not agree with you in placing the doubtful books where you did. So small differences in animals bother naturalists very much, and they try to overcome the difficulty by proposing other arrangements, and this is one reason why you find such different classifications in different books.

Where Found.— Crabs are found mainly in the sea, in shallow water, but some live in fresh water and some, in the warmer regions of the globe, entirely on land. These latter, however, visit the water to lay their eggs.

Habits of Crabs.— Some crabs swim well, others poorly, but all can walk backward, forward or sideways, often very rapidly. Some climb well. Most crabs, perhaps all, eat animal matter of some sort, either attacking living animals or feeding on carrion; some eat mainly vegetable substances. Crabs, like lobsters, have the power of growing a new limb if one should be lost in any way. Crabs hatch from eggs which are carried on the swimmerets of the mother.

The young are at first very unlike the old, so unlike that some of them have been described as different animals. Animals which pass through

* The possession of the hard outer crust is not sufficient alone to distinguish Crustaceans since other Arthropods often have the outside of the body hard. Crustaceans must also have more than four pairs of locomotive organs, and two pairs of attennæ, and *then* there are exceptions.

FIG. 6.—COCOANUT-CRAB

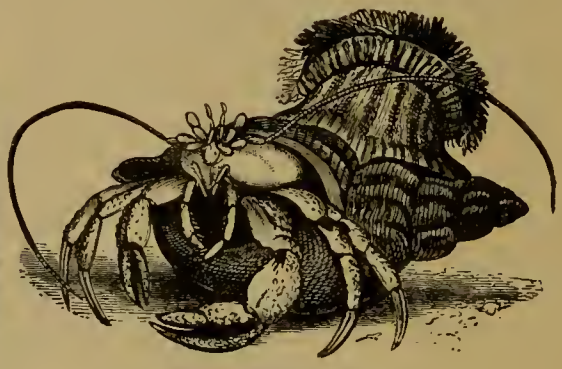


FIG. 7.—HERMIT-CRAB

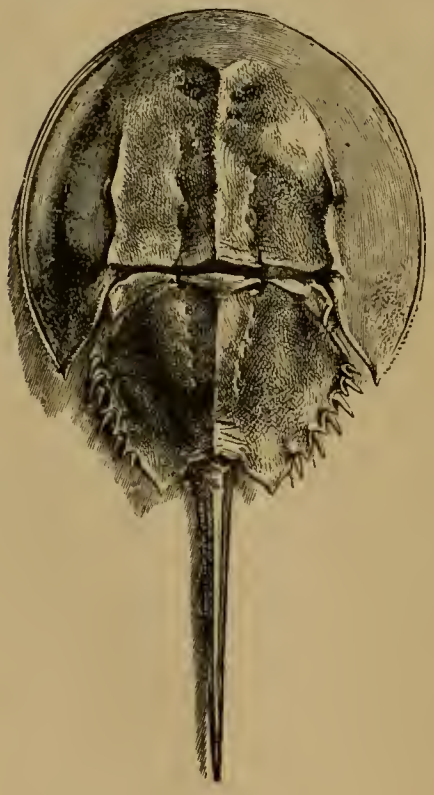


FIG. 8.—HORSE-SHOE-CRAB.

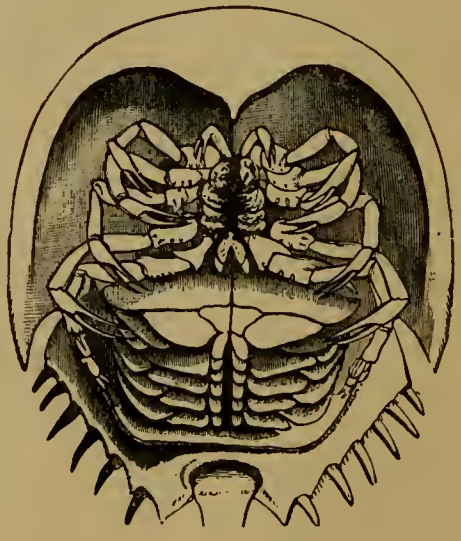


FIG. 9.—THE HORSE-SHOE-CRAB, UNDER SURFACE SHOWING JAWS.

great changes in form to reach the adult state are said to undergo a *metamorphosis*. Many creatures besides crabs do this. Can you think of any? During growth crabs moult several times, becoming each time more like the full-grown animal. The edible crab (Fig. 1) just after shedding his crust is sold as a delicacy in summer under the name of "soft-shell" or "shedder-crab." The illustration shows the edible crab of Europe; the American edible crab is essentially a swimmer and has the hindermost pair of feet flattened. At one stage of growth crabs resemble lobsters. (Fig. 2).

Kinds of Crabs.— There are many kinds of crabs; some are only a fraction of an inch across, and from this they vary to those which, with legs spread, cover a space of more than a yard square. One Japanese crab measures over ten feet between the outspread pincers, but the body is relatively small. One of the smallest is the little Pea-crab or Oyster-crab often found in oysters within whose shell it lives. A curious crab is the Fiddler-crab, whose right pincer is very much larger than the other, and when this is closed upon the front of the body he appears a little like a violinist ready to perform on his fiddle. He is also called Soldier crab and "Calling-crab," the latter, because when scuttling over the mud he waves his great claw aloft as if calling or beckoning to some one. Another interesting fellow is the Hermit-crab (Fig. 7) who, having only the cephalo-thorax hard, protects his abdomen by "backing" into an empty snail shell, leaving only his antennæ, big claws and first pairs of feet sticking out. When he outgrows his house which he carries around with him, he leaves it and hunts up another. Stranger still is the so-called Horse-shoe (Figs. 8 and 9) or King-crab, common on our Atlantic coast, which, however, is not really a crab at all.

There are some queer crabs with long thin legs known as spider crabs. (Fig. 5). They have a remarkable habit of getting under a sponge, forcing it open, and so getting it fixed upon their spiny backs. Of course the fish that saw a loose sponge rolling along towards it would never dream there was danger in it; but so it is, and the spider-crab gets a meal without much trouble.

Somewhat similar to the spider-crab is the thorn-back (Fig. 3) whose shell is thickly covered with spines and knobs of various sizes.

It used to be stated that the cocoanut-crab (Fig. 6) was in the habit of climbing the cocoanut palms, picking the fruit, throwing it to the ground, and then breaking the shells to get at the kernels. The climbing powers of this crab, however, do not appear to have been observed by any reliable person. You have sometimes seen in fruiterers'shops the cocoanut with its thick, fibrous overcoat on — of the substance of which cocoanut matting and door-mats are made. The cocoanut-crab tears this fibre off the fallen fruit, and gets to the end of the nut, where are the three smooth pits, the "monkey's eyes and nose." This crab has two pairs of pincers — the usual heavy pair and a thin small pair. With his heavy claws he hammers at one of the "monkey's eyes" until he has broken it through: he then inserts one of the small nippers, and extracts a portion of the cocoanut flesh, which he eats. And so he becomes fat and enticing food for the natives, who set out in parties to hunt him.

Besides feasting so daintily, the cocoanut-crab likes to take his rest cosily; so he digs out a deep cave beneath the roots of a tree, and in it he lays a thick, soft bed of the finest cocoanut-fibres, carefully selected, on which he reposes.

There are other land-crabs beside the cocoanut-crab. There is one in the West Indies, who makes his home chiefly in the forests far inland, living in holes. In the rainy season this species quit their holes and getting in enormous companies make their way straight for the shore. Nothing but broad rivers can stop them, and they do a vast amount of damage on the way.

Uses.— Have you ever eaten lobster or crab? Then you know what some crustaceans are good for, and will not be surprised to hear that thousands of people in the United States are busy catching, preparing and selling these creatures. If your home is in Boston or New York, or some

other city near the Atlantic, you may also have seen in the fish markets shrimps, which are relatives of the lobster and crab.

Crustaceans are also useful by acting as scavengers. How?

How Captured? — Crabs and lobsters are caught in traps, which are arched cages made of netting strengthened with hoops of wood or iron and having an opening on each of two sides. These are called "lobster-pots." They are baited with dead fish and sunk in the proper places, their position being marked by a float. The crustacean easily gets into these traps, but not out.

Suggestions and Notes.— In teaching this, as in teaching all lessons, *tell* as little as possible. *Draw out* by judicious questioning. For example, in beginning do not tell the color, the pupil ought to be able to tell *you*. So with every other point. Tell only such facts as the pupils do not know and cannot readily find out. When you come to the crab have the pupils in the same way see and tell you the various parts from the specimen, if you have such (and you ought to have at least one) or from a drawing previously made. Make a list of these on the board side by side with those of the lobster, and then, with this before them, ask the pupils whether on the whole the crab is like or unlike the lobster. Then you can ask for the points in which it differs, or saying nothing about these, let them form a subject for composition — "How the Crab differs from the Lobster" or "Why the Crab isn't a Lobster." Of course the less obvious parts you will omit with younger pupils. The amount that is taught is of less account than the way in which it is taught. A complete comparative list would be something as follows:

	THE LOBSTER.	THE CRAB.
Color, dark greenish.		dark greenish.
General form, long, cylindrical.		broad, flattish,
Main Parts.	head-thorax or cephalo-thorax.	cephalo-thorax.
	abdomen (7 pieces).	abdomen (7 pieces).
Other Parts.	pair stalked eyes.	pair stalked eyes.
	" antennules.	" antennules.
	" antennæ	" antennæ.
	" mandibles.	" mandibles.
	2 pairs maxillæ.	2 pairs maxillæ.
	3 " jaw feet or maxillipeds	3 " maxillipeds.
	pair pincers.	pair pincers.
	4 pairs walking feet.	4 pairs feet,
	5 " swimming-feet or swimmerets.	6 " swimmerets.

If you live within a hundred miles of the Atlantic you will know where to get specimens of lobsters and crabs. If you live farther off you can, probably, at times, get boiled lobsters, and by leaving a special order at your fish-market get fresh specimens. If crayfish are accessible use these, and by all means have some alive in a jar of water; put in with them some of the little snails found where you get the crayfish and they will serve as food for the latter. Your boys will be glad to catch all these for you.

Appended are a few subjects for composition; these will suggest others to you. If you have given the previous lessons in this series make this work comparative as much as possible.

1. Describe a lobster — size, color, number and shapes of legs, form, size and names of other parts; anything else you can see.

2. Describe a crab in the same way.

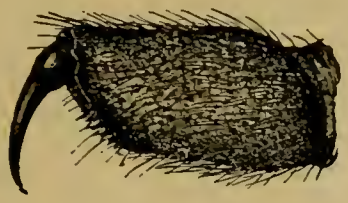
3. Describe the different things a lobster can do, what he eats, where he is found, what he is good for and how he is caught.

4. Combine 1 and 3 and tell all you know about the lobster.

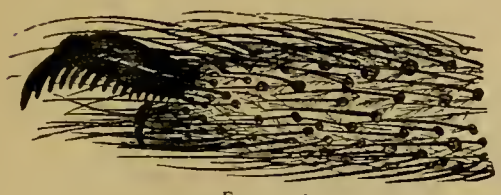
5. Write a complete description of the crab.

6. Compare the lobster and the crab, mentioning first the points in which they are alike, then those in which they differ.

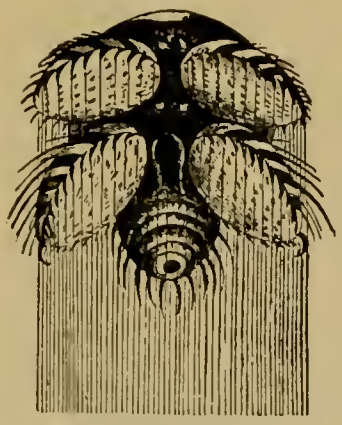
The teacher will find further information in the following books: Huxley, *The Crayfish;* Encyclopædia Britannica, articles *Crustacea*, *Crab;* Science Guide No. VII., Boston Soc. Natural History, *Worms and Crustacea;* Scribner's Monthly, June, 1881 (Vol 22, p. 209), *The Lobster at Home*, an entertaining account of the industrial side of the subject.



FANG OF SPIDER.



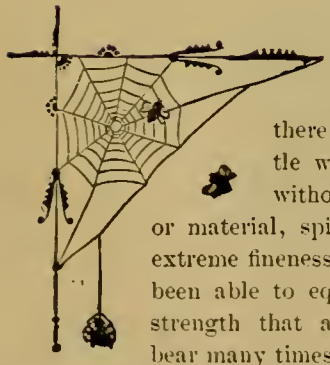
FOOT OF SPIDER.



SPINNING APPARATUS OF THE SPIDER (*greatly magnified*).

NOTES OF LESSON ON

SPIDERS.



Long before man had learned to weave cotton or flax or silk there were industrious little weavers in the world, without visible machinery or material, spinning cloth of such extreme fineness that man has never been able to equal it, and of such strength that a single strand will bear many times its own weight without tearing. They spread their dainty manufactures on shrubs and trees for his admiration and even brought them into his houses when not prevented. You can see fresh specimens of their handiwork still, and find them sparkling with diamonds of the dew, if you will but take a walk on the early morning of a bright day. Perhaps you have guessed that these weavers are the Spiders.

Let us examine the weaver himself. Notice that, roughly, he suggests a crab and like him has his body marked off into two main parts — the fore-part or *cephalo thorax* and the swollen hinder part or *abdomen*. From the under side of the cephalo-thorax spring the *four pairs of jointed legs*. On the forward end of the cephalo-thorax (which is the head end) are little spots — the *simple eyes*, two, four, six or eight in number — usually eight. There are no antennæ as in the crab and lobster and only *two pairs of mouth-parts*, the first corresponding to the *mandibles* of Crustacea, each mandible ending in a curved fang having an opening at the tip connecting with the hollow inside which contains a poison. The other pair are the *maxillæ*.

Abdomen.— On the under side of the abdomen are found the openings (*spiracles*) of the air tubes and of the so-called lung-sacs by means of which the spider breathes. At the end of the under side of the abdomen are one, two, three, or four pairs of little projections (*spinnerets*) from which the silken thread for the web passes out.

Internal Structure.— The spider has a *stomach* and also a *liver*. A tubular *heart* lies along the inside of the back of the abdomen,

which sends the blood to different parts of the body by the movements of the animal. He breathes through tubes (*tracheæ*) going to different parts of the body, or through pouches containing sixty or seventy little plates lying upon one another like the leaves of a book and forming the so-called *lung-sacs*. Sometimes he has both tubes and lung-sacs.

In his head is formed the poison which at the time of biting flows through the hollow fang, killing small animals which forms the spider's prey. The poison is even sometimes troublesome to man.

The abdomen contains the silk glands which secrete a sticky liquid that dries in the air to a thread. This liquid issues from numberless fine openings in the spinnerets, the lines from most or all of these uniting to form an ordinary web-fiber.

Like the lobster and the crab the spider belongs to the same group *Articulates* or *Arthropods*, but breathing through air-holes, having four pairs of legs and no hard outer crust, to a division of the group called *Arachnids* or *Spiders*.

Kinds of Spiders.— One spider differs from another spider as one crustacean differs from another; there is no monotony in nature. One of the smallest true spiders is about $\frac{1}{25}$ of an inch in length while one of the largest Brazilian spiders is over two and one-half inches long, spanning nine inches with outstretched legs. One so much resembles a crustacean as to be called the crab-spider, another so closely imitates an ant as to be known as the ant-spider.

WATER SPIDERS.

Besides the true spiders there are many other spider-like creatures belonging to the Arachnida, one very familiar one being the Harvest-man whose length of leg has caused him to be nicknamed by the children "Daddy Long-legs." Another common one is the little reddish or brownish book-scorpion frequently found in turning over the leaves of old books or in rummaging among old papers. He is a harmless creature, not really a scorpion at all, though the scorpions belong to the group. Degenerate relations of the true spiders are the tiny "red spiders" found on plants espec-

ially in houses, the cheese and sugar-mites, and the so-called "black-heads" or "face-worms." Some of these poor relations live in and on the body of man and other animals and are known as parasites.

Spiders are found in every part of the world, but of largest size and in greatest number in the tropics.

Habits.— Spiders hatch from eggs which in many cases are deposited in cocoons or nests. In appearance the young do not differ much from the old. The mother spider shows great attachment to the eggs and young.

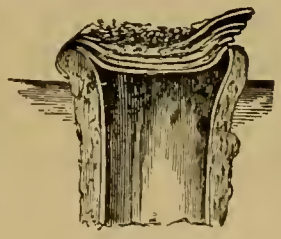
NEST OF TRAP-DOOR SPIDER.

Spiders shed their skin or *moult* as do crustaceans, and like these also seem to have the power of reproducing a lost limb. They prey on one another as well as on insects generally, and for the purpose of capturing their prey many kinds construct snares or traps of some sort. Others spring upon it unawares or run it down and these do not build a net. The most common snares of course are the webs; these are formed with the aid of the hind pair of legs which serve to draw the delicate stream of silk and guide it in fashioning the designs. Some webs consist of a horizontal sheet suspended among branches and held by lines in all directions; some of lines radiating from a centre and connected by cross-lines — the webs of the geometric spiders; some of a silken tube fitted into casual crevices with an entangling web at the opening; and others of a tube spun in a hole dug by the spider himself and sometimes closed with a lid (trap-door spiders).

TRAP-DOOR SPIDER.

The common garden spider which spins a geometric web, having chosen a suitable spot begins with a line or two across the point where the centre is to be. Radiating lines are then run from the centre in all directions. Then from the centre is spun a thread spirally around the web to the circumference and fastened to each radius as it is crossed. This spiral serves to keep the parts of the web in place and as a scaffolding to work on during the rest of the process and is removed as fast as the web is finished. Webs frequently require repair or renewal every night.

TRAP-DOOR, OPENING BY A LEVER.



SECTION OF NEST.

Some spiders are aquatic and make a cup-shaped net under water.

The same substance which serves to form the webs for catching prey is also put to other uses. By fastening one end the spider can safely drop from any height. By running out the thread where a heated current of air is rising and allowing it to be carried up until its buoyancy is sufficient to overcome the creature's weight the spider may be carried long distances.

The fine films (gossamer) in the air on calm October days are spider-silk, given out by various immature spiders, by means of which the tiny baloonists are carried by the wind from place to place.

"Fairy bands
Sailing 'mid the golden air,
In skiffs of yielding gossamer."

Uses.— Spiders are useful from the vast numbers of insects they destroy, while doing no damage to vegetation.

The thread of which their webs are made, and which also forms the egg-cases, has been proposed as an additional source of silk and small articles have actually been made from it, but the matter has not gone beyond the experimental stage.

Composition Work.— May consist in part in re-telling the substance of the lesson—as much as can be remembered — in part, also, in comparisons with the Ant, Bee, Silkworm, Lobster and Crab,— one or more of these, on points of structure, habits, or uses. Specimens you will know where to get. By keeping a Spider alive in a box covered with a piece of glass, or in a fruit jar, you can observe the making of the web but must not expect to find it as perfect as where the creature has its choice of situations. Incidental reading you will find in Morse's *First Book in Zoölogy*; information for yourself in Emerton's *Spiders*. The following poem may be used with older pupils.

THE GARDEN SPIDER.

THE CURIOUS HOUSE.

I know a house so fair and fine
  No flaw in it can you detect,
A silver beauty smooths each line
  Drawn by its patient architect.

To look upon its fragile frame
  And note its splendor in the sun,
No builder known to human fame
  You say, can do what this hath done.

It has no shingle, roof, or beam,
  It is not buttressed on the land,—
Its airy filagree and scheme
  Seem products of a fairy's hand.

How swung aloft, how lightly stayed,
  Without a window, board, or pane—
A dream in definite shape arrayed,
  A castle from the realms of Spain!

Though Piranesi might despair
  Its lines to mend when once undone,
I see its owner in the air
  Across the silver ramparts run.

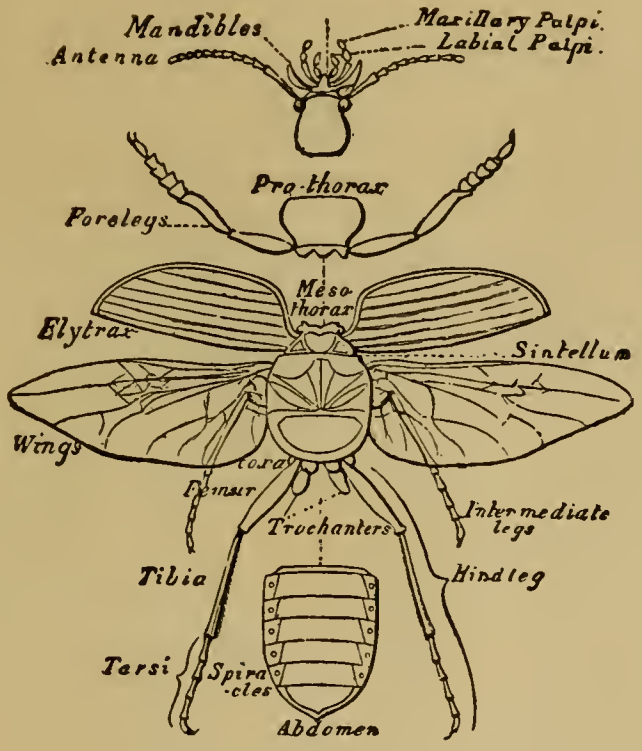
And where a break has crept into
  The checkered strands that greet the eye,
Has made the battered places new,—
  And not a scar can you descry.

On geometric curve and coil,
  Dew-diamonded beneath the sun,
This little builder's wit and toil
  Was spent until the work was done.

O silken house of gossamer,
  Thy woven wonder does not cease,—
And yet thy blood-stained doors deter
  Wayfarers fond of life and peace.

No revelers in those chambers meet,
  No jocund foot-steps jar the floor,—
For they who step within retreat
  At once, or leave it never more.

—JOEL BENTON.



INSECT, SHOWING PARTS.

NOTES OF LESSON ON

INSECTS.

(This lesson should be illustrated with diagrams and with specimen if possible).

I.—Why So Called. The Chief Organs.—Show from the illustration or specimen that the body appears to be *cut-into* in two places, giving three natural divisions to the body. Hence the name insect — *cut-into*.

The *head* carries the *mouth* apparatus, the *eyes* and the *feelers*.

The *chest* (or thorax) carries *three pairs* of legs below and *two pairs* of wings above.

The *body* (or abdomen) sometimes carries a *sting*; and sometimes a special organ for *boring*, and then *conveying eggs* into the holes.

II.—Segments and Joints.—Call attention to the rings of the body. Insects belong to the great subdivision of the boneless animals, which have the skin divided into rings or segments. Insects usually have *nine* segments in the body, and *three* in the chest and the head forms *one* piece. But all these segments are not always distinguishable except with the aid of a magnifying glass. They may, however, be clearly seen in the caterpillar, and the body segments are fairly dis-

tinct in most butterflies, moths, ants, bees, and flies.

The segments are formed of hardened skin, but the skin between the segments and which connects them is not hardened; it is pliant, tough, and elastic, and answers the purpose of ball-and-socket-joints. The segments themselves are not perfect rings. Each consists of two half-bands — an upper and a lower — joined by the pliant, elastic skin. This arrangement gives considerable freedom of movement. (See Fig.)

III.— The Head.— The head carries the apparatus of the mouth, the eyes, and the feelers. The structure of the *mouth* varies of course with the kind of food on which the insect feeds, but in one particular they all agree: when jaws are present they always open sideways, and not up and down like our own. There may be several pairs of jaws one behind the other; some are formed for cutting and tearing, others for crushing, and some have the edges toothed like a saw. Some insects have trunks instead of jaws through which they suck juices — it may be nectar of flowers, or the blood of other animals.

The *eyes* are not single like those of vertebrate animals; but each eye consists of a large bunch of very small eyes. Each eye may thus be made up of thousands of small eyes. They usually stand well out from the head so that the insect may see in every direction — above, below, beside, before, behind.

The *feelers*, one on either side of the head, are of various forms, shapes and sizes. That they are of great service to the insect, is quite certain, for the animal cannot live long without them; but of their exact use we are ignorant. They may be organs of feeling, sense or hearing.

IV.— The Chest. — The chest carries the *legs* and *wings*. The legs are always *six* in number. The *wings* are usually *two pairs*. Very often, as in the beetles, the front pair are hardened, and used to *protect* the second pair, and not for flight. In some of the flies the second pair is wanting, but their place is marked by two little stalks with knobs at the ends. *Balancers* they have been called, because it seems they act as balancers during flight, and the insect cannot fly without them. In a few insects the wings are entirely wanting. Some of the ants shed their wings after a certain period.

V — The Body.— The segments are usually distinct in the body. In those insects whose front pair of hardened wings covers the upper surface of the body, the segments are solid below only and not above. The wing-cases, in fact, do the duty of the hardened skin.

A close examination between the segments, and between the upper and lower half of the same segments, will discover a number of small holes on either side; these are the ends of fine tubes, which communicate with two larger trunks running along each side of the body. From these main tubes other and smaller tubes branch off, and these again send off smaller tubes which traverse every part of the body. These tubes are prevented from collapsing, or falling together, by a kind of *elastic* spring coiled up closely between the two membranes of which the tubes are built up. These tubes are the breathing organs of the insect. It has no provision by which the blood is brought to one particular part for cleansing, and so the air is taken to the blood-vessels in every part of the body. By this beautiful arrangement not only is the insect endowed in proportion to its size with life, vitality and strength beyond all other animals; but its weight is reduced to the extreme limit.

I.— Kinds of Insects.— The teacher may ask for the names of insects, and make a rough classification.

Insects are usually grouped according to the structure, arrangement and number of the wings. The following may be taken as *types* of the chief groups, and the attention of the children should be drawn to the structure of the wings, either by drawings or specimens. Beetle, grasshopper, dragon-fly, bee, butterfly and house-fly.

1.— Shield-Winged.— In the beetles, the first pair of wings are horny or leathery, in texture. They form a pair of folding shutters, and serve as a *shield* to protect the second pair, which are folded crosswise, and packed away beneath. The

hinder pair are much larger than the front pair, and alone are used as organs of flight. This group includes all the beetles, of which eighty thousand of different kinds have been described.

2. — Straight-Winged.—The grasshopper has wing-cases like the beetle, but they are thinner, and show a net-work of veins; and instead of folding straight down the back they *over-lap*. The hind wings are folded lengthwise, and *straight* like a fan: hence the members of this group, which includes cockroaches, crickets and locusts, are called *straight-winged*.

3.— Lace-Winged.—The wings of the beautiful dragon-fly are all used for the purpose of flight. They are transparent, and so full of veins that they look like delicate lace, hence the name *lace-winged*. The May-flies, which live but for one day, and the *white* ants belong to this group. The dragon-fly can fly backwards as well forwards, and with lightning-like speed.

4. — Membrane-Winged. —The bee, like the dragon-fly, has four transparent wings; but the veins are much less numerous. The name is not a good one, because all wings are membranous; but there is no difficulty in distinguishing members of the group because the hinder pair of wings are fastened to the front pair by little hooks along the edge. Bees, wasps, ants, and saw-flies are *membrane-winged*.

5.— Scale-Winged.—The butterflies and moths are distinguished by having their wings covered with beautiful scales, and hence are called *scale-winged*. When handled the scales adhere to the fingers as dust; but under the microscope they are beautiful objects.

6.—Two-Winged.—The gnats, the common fly, and many other flies have two wings, hence the name.

II.— Benefits derived from Insects.— Insects are small, and as an article of food for man of not much importance: but as a diet for bats, birds, frogs, toads, etc., they are of incalculable benefit.

The larvæ of beetles, and the caterpillars of butterflies and moths, are eaten with much relish in same parts of the world. Locusts have formed an article of diet in North Africa from time immemorial, and white ants furnish an abundant supply of food for the Hottentots of South Africa. Bees provide us with honey and wax, and silk-worms with silk. The cochineal insect yields a fine scarlet dye, and to the gall-fly we are indebted for the chief ingredient in the manufacture of black ink. Some insects also act as scavengers, removing decaying animal matter which would otherwise taint the air; and they act as checks on themselves, one species preying upon another, and thus preventing its too rapid increase.

III.— Injuries Caused by Insects.— Some insects cause us annoyance rather than injury, the common house-fly, for example; others, like the mosquito and gad-fly, are nothing less than tormentors; but some there are which in their vast numbers become veritable scourges.

INSECT AND SPIDER (a comparison).

Illustrate by diagrams and pictures.

INSECT.	SPIDER.
a. *Body* consists of three parts.	a. *Body* consists of two parts. (Head and thorax form one part.)
b. *Segments*, distinguishable.	b. *Segment* not distinguishable.
c. *Skin* hard, except between the segments. Cast only in the larva stage.	c. *Skin* soft and leathery. cast at irregular intervals during life.
d. *Legs*. Three pairs, each made up of *five* pieces; claws at end.	d. *Legs*. Four pairs, each made up of *seven* pieces; (thigh, and leg each *two* pieces); claws at end.
e. *Wings*. Two pairs, of which one pair, or both pairs may be wanting.	e. *Wings* never present.
f. *Feelers*. One pair: vary very much in form. Probably used for feeling.	f. *Feelers*, changed into a formidable pair of jaws. Each consists of two pieces, of which the outer is claw-like and capable of being folded back into a groove of the other. Canal throughout connecting with poison gland.
g. *Spinning* apparatus, found in some insects, especially catipillars. Thread passed out through mouth, and hole in lip. Spin cocoons in which to live, or pass from larvæ to pupa state, or thence to the perfect insect.	g. *Spinning* apparatus possessed by all spiders. Spinnerets on under surface of body near the end. Spins cocoons as egg-cases, also webs as traps, or habitations.
h. *Eyes*, compound, a pair, each containing a large number of simple eyes.	h. *Eyes* simple, and varying in number from *one* to *six* pairs.
j. *Breathing* apparatus consists of tubes running throughout the body.	j. *Breathing* apparatus little sacs opening on the under surface of the body towards the front. A few have air-tubes also.

NOTES OF LESSON ON

THE BEE.

BLACK-BOARD OUTLINE.

Description.
- 3 Main Parts { Head. Thorax. Abdomen.
- Eyes, { Compound. Simple or Ocelli.
- Feelers or Antennæ.
- Mouth-parts. { Mandibles. Maxillæ. Proboscis.
- Wings,— 2 pairs.
- Legs,— 3 pairs.
  - Basket.
  - Pincers.
  - Brush.
- Abdominal Rings.
- Sting.

Kinds of Bees.
- { Social. Solitary.

Habits of the Hive-Bees.
- Social — Colony; Swarm.
- Division of Labor, { Queen. Workers. Drones.
- Building the Comb.
- Laying Eggs.
- Feeding the Young.
- Brooding the Young. (Metamorphosis).
- Swarming.

Uses.
- { Aid in Fertilizing Plants.
- Make. { Honey. Wax.

IN a weight of two grains and a length of half an inch are contained apparatus for changing the sweets of flowers into one kind of nourishment for itself, another for the common brood, a third for the royal brood, glue for its carpentry, wax for its cells, poison for its enemies, honey for its master, and a sting so sharp that magnified by the microscope which makes a needle's point seem a quarter of an inch, it would still be invisible. What is it? Let us see.

Main Parts.— Head, Thorax, Abdomen.— Notice that the body is in three main divisions: the *head*, the *thorax*, the *abdomen*. (Fig. C.)

There are three pairs of legs and two pairs of wings fastened in the middle division or thorax. Such a creature is an insect and this wonderful little body we will study more fully.

The Head.— Eyes, Feelers, Mouth-parts.— Looking first at the head-end, on each side

find — right and left — a little bulging spot. These are eyes, but, unlike our eyes, each is made up of very many single eyes closely set together, so forming what are called *compound eyes*, and of these compound eyes the Bee has two. Besides these, on the top of the head, are three little spots which also help in seeing, and these simple eyes are known as *eye-spots* or *ocelli* to distinguish them from the compound eyes. It is supposed that the simple eyes or ocelli are for seeing objects near by, while the compound eyes are for seeing things at a distance. The compound eye of the Bee consists of over three thousand little six-sided pyramidal lenses lying side by side, the points of the pyramids directed toward the inside of the head and the broader ends forming the convex outside of the eye. Most full-grown insects have both kinds of eyes, though some, as the "Potato-Bug," have only compound eyes. Between the eyes are two thread-like projections, one directed toward each side, consisting of little jointed pieces. These move about and are the *feelers* or *antennæ*. Their use is what their name indicates — to feel with — but perhaps they are also good to smell with or to hear with, that is, they may be also noses or ears.

We next come to the mouth-parts which consist of two jaws or *mandibles* that move from side to side (instead of up and down, as in us), two lesser jaws or *maxillæ*, which move in a similar way. These are the biting mouth-parts: besides them there is also a *tongue* or *proboscis* for lapping up flower juices.

Thorax, Wings, Legs. — The thorax or middle division of the Bee is thickly covered with very fine short hairs. On the back or upper side of the thorax find attached two pairs of thin, transparent *wings*. When flying, the two wings of each side are fastened together by tiny hooks along their nearest edges so that they move together as a single broader wing. These hooks can only be seen with a microscope. On the under side of the thorax find three pairs of jointed *legs*,— the hindermost pair longest — each consisting of three principal parts: thigh, shank and foot. On the shank of the hind leg of the Worker-bee is a little pit or pocket in which the yellowish flower-dust (pollen) collected by the insect is carried and which is therefore known as the pollen-basket or simply, the *basket*. The joint connecting the shank and foot of the same leg is so arranged as to form a sort of *pincer*, which this part from its use is called. On the foot is a row of hairs used to brush off the pollen from the body and this is the *brush*.

Abdomen.— Rings, Sting.— The abdomen or last main division is readily seen to be made of rings. (This is also true of the thorax, but the rings do not show so well there, in fact the entire insect is made up of rings or segments and in common with many other creatures which have this ringed structure it belongs to a great group of animals formerly called Articulates, which group has since been split up into Arthropods and Worms, the Bee, with all other insects, belonging to the Arthropods.) If you carefully count the rings on the abdomen of the Bee you will find six. Beneath these rings on the under side of the abdomen the substance called wax is secreted. At the end of the abdomen is the curious *sting*. This consists of two lances or darts compared to which the finest needle is a very rough instrument. On one of these lances are minute hooks pointing backward. The lances are protected by a sheath of two pieces and connected inside the abdomen with a little bag of poison. When the bee uses its sting it sometimes breaks off and then the bee always dies, though not instantly.

Kinds of Bees.— There are many different kinds of bees and a still greater number of creatures more or less nearly related to them. Some of these live and work together in families, others live by themselves. Animals that live and work together are said to be be *sociable*: those that live alone are *solitary*. Among the near relatives of the Honey-Bee are the Humble or Bumble-bees which are social, and the Carpenter-bees which are solitary.

The Hive-Bee.— Habits.— The Honey-bee or Hive-bee we are studying is a social insect liv-

THE MASON BEE.

THE CARPENTER BEE.

THE UPHOLSTERER, OR LEAF-CUTTER BEE.

ing in families composed of many thousand individuals. Each such separate family is a *swarm*. In each swarm there are three different sorts of bees which attend to different parts of the work: they are known as *Queen*, *Workers* and *Drones*.

The Queen-bee is more slender and a trifle larger than either of the others and there is but one Queen in a swarm. She has a sting, but no "basket," and does not go out to gather nectar or pollen. Her chief work is to lay eggs. She may live several years and lay over a thousand eggs a day during the honey season.

The Worker-bee is smaller than the Queen and in greatest numbers in the swarm, commonly forming nine-tenths or more of it, or about 15,000 in an ordinary hive, though the number varies with the season and other circumstances. The description at the beginning applies especially to it. It goes out to gather the sweets of flowers, out of which it manufactures honey. The sweet juice of flowers which the boys call honey is not honey, but *nectar*, till the bees have worked it over. The Workers gather also pollen or "bee-bread." Both the honey and the pollen are to feed the young bees. Out of the food they eat, the Workers make wax for combs. To sum up: they gather nectar and pollen, they feed the young bees, they clean and ventilate the hive, they brood and defend the young, they build the comb out of wax which they secrete and store it with honey which they also make. The workers live on an average about six weeks, but may live six months through the winter.

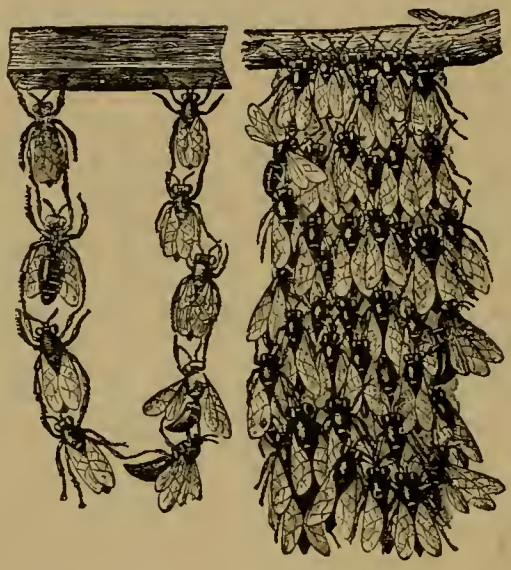
The Drone or male bee is nearly or quite as long as the Queen, but easily distinguished by its plumper form and the fact that the great compound eyes meet on the top of the head. The Drones are less numerous than the Workers in any hive. They have no pollen-basket and no sting and seem to do no manner of work but live off the labors of the Workers. Yet without them there would be neither Queens nor Workers. (Do you think they are entirely useless?) Because Drones appear to do no work we sometimes call a lazy fellow a drone, but bee-drones and human-drones are not to be compared. It is not always safe to judge of the importance of a creature by what it seems to do; there are different kinds of work in the world, all equally important. The Drones live about four months. At the close of the honey-season they either die of hunger or are stung to death by the Workers.

Building the Comb.—The comb is built from above downward, and consists of very many six-angled chambers or cells closely set side by side. These are partly built as nurseries for the young, partly as store-houses for honey. We know them best as honey-comb. In building the comb many bees work together, and if you were to watch them you would see a Worker take one of the little scales of wax from the under side of the abdomen with his "pincers," bring it to the mouth where it is softened, and then in the form of a thread or ribbon lay it on with the feet to form the wall of a cell.

In some of the cells, the Queen-bee lays an egg, out of which in three days hatches a little worm-like grub or maggot (*larva*, the naturalist calls it). This is fed with honey and pollen by the Worker-bees, and in about ten days it has become so large as to fill the cell. It now stops eating, and the bees close the cell above with a lid of wax. Then it lines the inside of its cell with a kind of silk, and passes into an inactive state (*pupa* or *chrysalis*). The bees hang in dense clusters about it, brooding, and in ten days more, a fully developed bee comes out of the cell. This passing through distinct changes from early life to maturity is known as a *metamorphosis*, and most insects in common with bees have a more or less complete metamorphosis.

In a few of the cells on the edge of the comb, the grubs are more carefully fed and tended, and these finally turn into Queens in about sixteen days from the time the eggs are laid. One of the most wonderful things about bees is that the larva of a Worker can, by proper care, be developed into a Queen, although the eggs for Workers and for Queens are laid at different times, and in specially made cells. The larva of a Drone never produces

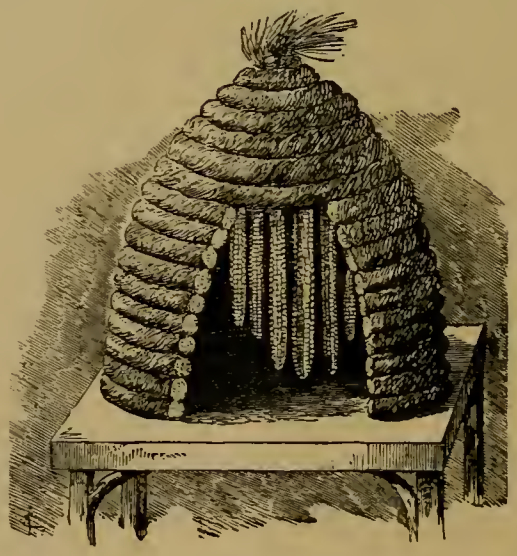
anything but a Drone. The eggs are laid in regular order, first those which are intended to produce Workers, afterward those for Drones and Queens.



Swarming.— When a new Queen is born, the family divides, and some bright day the old Queen leaves the hive with many of the Workers and Drones to find a new dwelling. This is called "swarming." The new Queen remains in the old hive, or, if more than one is born, the earlier also flies off with her company of Workers and Drones, leaving the hive to the latest-born Queen. Should two Queens meet in the hive, they attack each other until one or both are killed.

Uses.— From the sweet juices of flowers, the bees make the delicious substance called honey. The flower juice swallowed by the bee passes into the crop or "honey-bag;" here it undergoes some changes, and when again given out from the mouth, it is honey. With this the cells are filled, and when each cell is full, it is sealed tightly with wax. The first hives used by bees were the hollow trunks of trees, but man having found it profitable to raise bees, supplies the hives himself. One who raises bees is an *apiarian*.

Bees do still more important work than making honey or wax for man's benefit, in helping to fertilize and cross-fertilize plants. It has been found that some flowers never set seed unless they are visited by bees. Others are found to develop a greater number and more vigorous seeds if visited by bees. The pollen of the flower needs to reach certain parts in order that the plant may set seed. Some flowers are so shaped that this cannot happen except with the help of bees, which dusted all



over with the pollen they have been gathering, brush some of it on the necessary part, and so help the plant to set seed (fertilize it) or carry it from one flower to another (cross-fertilize it).

NOTE.— Information on the senses or mental powers of the insect will be found in Lubbock's *Ants, Bees and Wasps*, chapter on Bees. Specimens of wax and honey are of course readily obtained. A piece of honey-comb with the honey washed out, will show the form and arrangement of the cells. A few workers and drones, possibly a queen, can be obtained from any friend who keeps bees. If your pupils are old enough, have them read all, and commit to memory parts of Emerson's poem of "The Humblebee."

NOTES OF LESSON ON

THE ANT.

GENERAL DESCRIPTION.

THE BROWN ANTS' DAIRY FARM.

Just as in the butterfly and the bee we find the body of the ant divided into three principal parts which are severally named: *head, thorax, abdomen.* To the head are attached the eyes, the antennæ or feelers, and the powerful biting mouth-parts; to the thorax the legs, and sometimes also wings; the abdomen consists of six or seven jointed rings, and to it is usually attached a sting. As among bees, we find three different sorts of creatures in an ant family: males (called drones in the case of bees), queens, and workers, differing somewhat in size and structure.

Antennæ; Eyes, Simple, Compound.—The *antennæ* consist of a spherical piece near the head, a long shaft, and a whip-like end of from six to seventeen short-jointed pieces, the number varying in different kinds of ants and also in males and females of the same kind, the males of any kind generally having the greater number.

The *eyes* are of two kinds as in bees, *simple* and *compound.* The *simple eyes* or *ocelli* are in the front of the head, from one to three in number (usually three arranged in a triangle) and always present in queens and males, but absent in some workers. The *compound eyes* are found on the sides of the head, one on each side and occur in all ants. Each of the compound eyes may be said to consist of a great many single eyes or facets. Sometimes as many as twelve hundred, the number depending not only on the kind of ant and whether male or female, but also, curiously, on the size of the creature — the larger the ant the greater the number.

Legs, Wings, Spiracles.—The thorax bears in all ants three pairs of legs and in the males and queens also two pairs of wings, which, however, are soon stripped off by the insects themselves. The workers are wingless. In the thorax are also three pairs of tiny holes through which air gets into the body — the *breathing holes* or *spiracles.*

Abdominal Rings; Stings.—The abdomen consists of six pieces in the queens and workers, and of seven in the males. It also bears a pair of spiracles, and usually a sting, except in the males.

Ants therefore, in a general way, are built like bees and belong to the same great branch of the Animal Kingdom — Arthopods (old name Articulates) — and having the body cut or *insected* into three main parts — to the same division of the of the branch — Insects.

WHITE ANT.

Kinds of Ants. — Ants are found, speaking generally, all over the world and are of many kinds, but they do not differ so markedly in appearance as is the case with some other insects.

This so-called white ant of the tropics, however, is not an ant at all.

Habits.—Like most other insects ants undergo great changes before reaching the adult stage — that is, they pass through a *metamorphosis.* Out of the minute whitish or yellowish eggs there hatches in from fifteen days to six weeks a tiny, white, legless grub or *larva*, whose chief business it is to eat and grow.

After a period of eating and growing, ranging from less than a month to about two, (occasionally lasting through the winter) this fat little creature passes into a quiet state, sometimes (but not always) spinning for itself a silken cocoon, inside which further changes takes place. These cocoons are the so-called "ant-eggs" frequently found on stirring up the surface soil, and which the ants so hurriedly carry off to a place of safety. During this period (the *pupa* or *chrysalis* state) it takes no food. After remaining a certain length of time in this condition, it emerges as a *perfect insect* in which process it is assisted by the older ants (workers) who carefully unfold its legs and smooth out its wings, "with truly feminine tenderness and delicacy" as Sir John Lubbock, who has spent much time watching ants, observes. As a perfect insect, the ant that we are familiar with, it again takes food but does not grow, being as large when it comes out of its pupa-case as it ever will be. In this full-grown state it may live seven years or even more — the males, however, usually only a very short time.

Like the honey-bees, ants are social insects, dwelling in communities often exceedingly numerous. In any community there are ordinarily three different forms: *workers* who form the great majority; *males*, and *queens* — of the latter, unlike with hive-bees, there may be several. As among bees, also, the workers attend to the daily labors, and the queens lay the eggs from which future workers, queens and males arise.

Ants differ much in character, some species are very timid, while others will fight till death. Some are thievish, haunting the battlefields of larger kinds and devouring the dead. In industry they are not surpassed by any other animals; they work all day and in warm weather, if need be, at night too. They make roads, by carrying off the obstacles, and in some cases arch them over with earth forming covered ways. Their dwelling places or "nests" are built of bits of stick, leaves, etc. heaped up, or of earth, or they tunnel out the trunks of old trees for the purpose. Some are above ground, others entirely underground and often very extensive.

They store up grain for winter use and even keep other insects that they can make use of. The common garden ant can frequently be seen ascending bushes in search of *plant lice* (aphides). Watching you see the ant tap the aphis gently with his antennæ and the aphis gives out a drop of sweet liquid, (honey dew) which the ant drinks. The aphides are the so-called "cows" of the ants and are protected by them from other insects, but aphides are not the only insects which the ants use as cows. The indefatigable industry of the ants is referred to in the well-known passage of Solomon, but you must not think all ants either store up provisions or keep cows.

Our ants generally go out hunting singly, but in warmer climates many hunt in packs or even in armies. Those who have watched them carefully, say that ants also engage in certain exercises which it is hard to believe is not play.

One curious practice engaged in by some ants, is that of slave-making. In these expeditions the slave-makers invade a nest of other ants and carry off the young which afterward do the work of their masters. In some cases the masters have become entirely dependant on their slaves; these attending to the building of the nests, the care of the young, and the providing of the daily food. Some have even lost the habit of feeding themselves, and would starve unless fed by the slaves, "a striking lesson of the degrading tendency of slavery," as remarked by Lubbock. Yet the "workers" of this slave-making ant fight ferociously.

Uses.— Ants feed on other insects and in fact on nearly all animal matter, on fruit and all manner of sweet substances. They may be useful by destroying insects but since they make no discrimination in the insects they remove, this is doubtful. On the other hand they encourage aphides, which is certainly not a benefit, but in the disposal of decaying matter they deserve a share of credit.

NOTES OF LESSON ON

THE BEETLE.

(Show a picture, or black-board drawing of the beetle, and specimens, if possible, should also be provided for illustration.)

INTRODUCTION.—Refer to the different kinds of living creatures about which lessons have been given. What other living creatures have we heard of? Speak of bees, butterflies, ants, etc. What are these called? What are insects? To-day's lesson tells of one kind of insect — the beetle.

General Description. — Show picture and describe its general shape; the small head, with two horns upon it; the body like the wasp, butterfly, bee, etc.; divided as though nearly cut into three parts.

THE BODY.— Is covered by two large wing-cases. These are hard and differently colored: some are black, some brown, some prettily striped and spotted. Under the hard cases many have two soft, thin, delicate wings. Some beetles have no wings.

THE CHEST (*Thorax*).— This is smaller than the body, but hard. Below it grow the legs. Count them. There are three on each side. How many altogether? They are long, jointed, and have long, tiny, hook-like claws. Show how by these they can lay hold of the rough walls, bark of trees, etc., and run quickly up or down.

THE HEAD.— In it are the eyes. These stand out so that the beetle can see on all sides of it. The two *horns*, one on each side of the head. They are called *feelers*. Some are very long. The beetle moves them about quickly. By them they feel their way, find their food, and so make their way about in the dark.

THE MOUTH.— Below the head. It looks small, but in it are a kind of sharp, strong teeth.

Kinds of Beetle.— THE HOUSE BEETLE.— These live in our houses. They hide away in dark, damp cellars, under the floors, in cracks and crevices of walls, etc. When do they come out? They run over the floor and feed on crumbs of bread and other things dropped about.

GARDEN BEETLES.— Some are very small, with prettily covered wings.

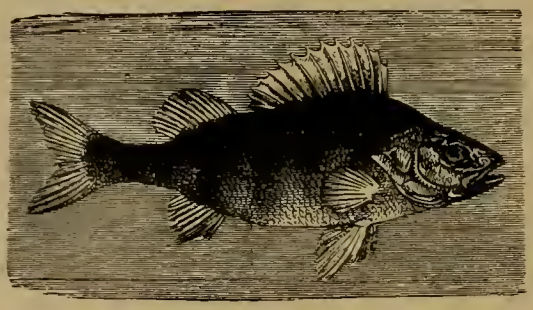
THE GREAT STAG BEETLE.— This lives in trees. Describe its two great stag-like horns. It is one of the largest found in this country.

THE DOR BEETLE.— This flies about in summer nights. Sometimes striking against our face as we walk along the country roads.

THE TIGER BEETLE.— This is very pretty, with bright green wings, with white spots and little stripes or markings upon them. But it is very fierce, catching other insects and killing them for its food. This will tell you how it gets its name.

WATER BEETLE.

THE WATER BEETLE.— Many live in water. Some very large. These live in mud at the bottom of the ponds, but they come often to the top to breathe. Many beetles swim and glide about the surface of the water in the summer. What are the different parts of the beetle? Name the different kinds? Where, and how, they live, etc.



NOTES OF LESSON ON

FISHES.

[Illustrate with pictures, a dead specimen, and, if possible, a live specimen in water — a gold fish, for instance].

I.— INTRODUCTION.

FISHES are inhabitants of the water, either fresh water or salt. Here they are born, here they live, and here they die. They are not, however, scattered without order or arrangement; on the contrary, just as in the case of land animals, their instincts lead them to make a home in that part best adapted to their well-being. Some live near the surface of the ocean, others never quit the depths; some revel on the sandy floor, others grovel in the ooze and mud; some never quit the salt water, others spend a portion of their time in the waters of rivers; some are altogether fresh-water fish. We find similar habits of life, too, in the water as on land; some fish live in solitude, others in shoals; some occupy the same locality all the year; others in vast numbers migrate from one part to another.

The typical form of a fish is well known, but we find other and curious shapes. Some fish are round as globes, others are flat as boards; some are as broad as long, others are long and thin, with scarcely a difference in thickness throughout.

The body is usually covered with scales, and these are of all shapes, sizes and colors. They vary in size from a point to a plate; and in color from the dullest shades to the brighest hues of the rainbow.

Fishes feed on succulent marine vegetables; on worms and shell fish, but mostly they devour other fish. In the sea, might is right; the great ones eat the small, and the strong devour the weak. They have no respect for even their own kindred.

It will be impossible for us to consider the variations in form and structure of the vast multitude of fishes. It will be sufficient for us to take a common example — the Codfish or Mackerel — to show how beautifully fishes are fitted for the watery element in which they live. We shall first ask and answer four questions — *How do fishes move? How are they protected? How do they breathe? How do they feed?* And it will be convenient to answer the first two in this lesson.

II.— HOW DO FISHES MOVE?

1.— Shape of Body.

By actual experiment in a vessel of water, show that one *form* of body can be moved more easily through the water than another. Take a cone or a wedge of wood, for example, and pass through the water, first with the base forward and then with the point or edge. Show next that the body of the fish is shaped something like a pair of wedges set back-to-back; the hinder one coming almost to a point, but with the edges pared off. Refer to the shapes of boats, and elicit why they are so

shaped, and generally lead up to the proposition, that the body of the fish is so shaped that it can be moved through the water with the least possible amount of force.

2.— The Tail and Fins.

Make a black-board outline. The attention of the children should be drawn to the graceful sweep of the hinder half of the body and the tail from side to side, and the consequent motion forwards. Refer to the way in which a boatman propels his boat with a single oar placed over the stern of the boat. The boatman imitates the fish in this use of the scull.

The fins vary in number and position, but most fishes have *five* kinds. Just behind the head there is one pair; these correspond to the fore-limbs of mammals, and are called *Pectoral*, *viz:* breast fins. A second pair corresponds with the hind-limbs. These are the *Ventral*, *viz:* belly fins. In some fishes these are placed as far back as the tail, in others as far forward as the throat. Besides the *Caudal* or Tail fin, there are other fins placed perpendicularly along the upper and lower sides of the body. These are the *Dorsal* and *Anal* fins. With the exception of the *Caudal* fin, the chief use of the fins is for *balancing*. Cut off the fins and the fish rolls over on to its flat side. The fins are merely folds of the skin spread out, and strengthened and supported by bony spikes.

III.—THE COVERING OF FISHES.

The general covering of mammals is *hair*, that of birds, *feathers*, that of fishes consists of *scales*. The teacher will show the scales of any fish he may have secured. He will call attention to the way in which they are arranged on the body; how they overlap like shingles on a house, but from head to tail instead of from above downwards. The front edges of scales are embedded and held firmly in folds of the skin. The fish-dealer, to remove the scales, scrapes his knife from the tail to the head. By this means the knife gets under the free edge of the scales, and forces them off. The scales form a beautiful protecting skeleton, and at the same time admit of perfect freedom of motion. The slimy covering over the scales will next be brought under notice, with the purpose it serves; and lastly, the teacher may deal with any modifications in the scaly skeleton as time and opportunity offer.

IV.—HOW THEY BREATHE.

Explain to the children first of all what is the real essence and object of breathing, *viz:* getting fresh air in contact with vessels containing the blood, so that the oxygen may get in through the walls, and the impure air may come out. The blood must thus be cleansed or the animal dies. The larger land animals take air into *lungs* or *sacs*, the walls of which are covered with blood-vessels, and the exchange of pure for impure air is thus made. But fishes living beneath the surface of the water cannot make the exchange in this way. All natural water contains a certain amount of air, and it is this air which the fish has to take out. When water is boiled this air is driven out, and if a fish be placed in water lately boiled, it turns over on its side and dies without a struggle. Its blood-vessels are arranged on a bunch of leaflets placed on each side of the head — the gills; and over these gills the water is constantly flowing. The gills may be called the lungs of fishes, because they have to serve the same purposes.

Show the gills of a fish. They look like fringes. Under the microscope they are seen to be full of thin-walled blood-vessels. As the water flows over these blood-tubes, sufficient air passes through the thin walls from the water to the blood to keep the latter pure. Of course, at the same time, the impure air escapes into the water. When a fish is taken from the water the gills shrink and fall together and become dry; and the fish dies because its gills cannot do their work. The fish is, in fact, suffocated for want of air, just as much as a mouse would be suffocated if held under water. Both die for want of the necessary air.

If we watch a fish we see that it appears to be constantly drinking. This is not so, however. The water, it is true, is taken into the mouth, but it is passed back over the gills and out through

the holes at the sides. The throat is closed meanwhile, and no water enters the stomach.

V.—HOW FISHES FEED.

To learn how fishes feed we may look at the mouth, the teeth, the tongue and the lips. The lips are horny, and hence there can be little or no sense of feeling. The tongue is also immovable, and often bony or beset with bony plates, hence the sense of taste can be but slight. The teeth are very variable in number, form and position: but, for the most part, they are simple conical spikes with the points bent backwards towards the throat. These teeth are suitable for seizing and holding, and not for chewing. We may learn, therefore, by a simple inspection of the mouth, that fishes mostly catch their prey alive, and swallow it whole.

VI.—SPECIMEN FISH.

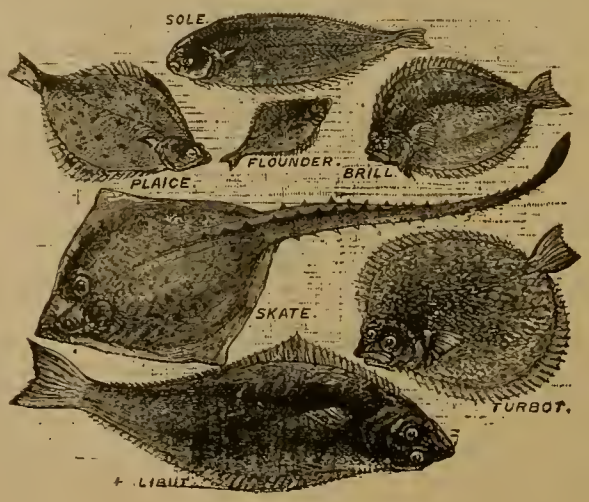
The teacher should now direct attention to any peculiarities in structure and habit of such common fish as are within his reach. We take two illustrations, a Flat Fish and Eel.

1.— Flat Fish.

Most people imagine that the dark side of a *flat* fish is the back and the light side the belly; but really these fish are compressed sideways like the herring, only to a greater extent. Then both eyes are on the dark side, but when quite young the eyes were on both sides. As the animal grows, one eye works round to the same side as the other. If we look at the fish at home these peculiarities in structure would be explained at once. Flat fishes spend much of their time either resting on, or partially covered by, the sand or mud at the bottom of the water; and the color of the fish so much resembles the floor on which it rests that it is not easily distinguished. Again, resting on the mud or sand, an eye on the lower side would be worse than useless. Dorsal and ventral fins extend quite along the body from head to tail. The scales are very small, and so are the teeth.

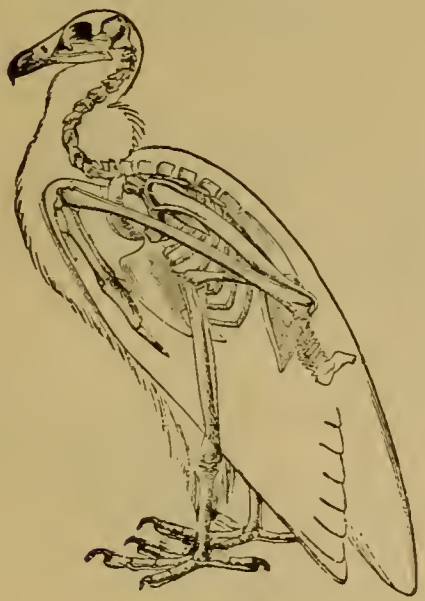
2.— Eels.

This fish takes the shape of a snake. It looks and feels as if it had no scales. It has, however, a vast quantity, though so small as to be almost invisible. Eels are very slimy fish and difficult to hold. The chief peculiarity in the eels, besides their shape, is the arrangement of the gills. Instead of the opening of the gills for the exit of water being close at hand, it is placed far back, and consists of but a small hole. When this hole is closed the fish can keep its gills moist for some time, and thus live out of water. In fact it occasionally happens that when one piece of water is pretty well dried up eels migrate to another place, creeping over the ground like snakes. Eels pass the winter in a torpid state in the mud.



NOTES OF LESSON ON

BIRDS.



-Skeleton of Vulture.

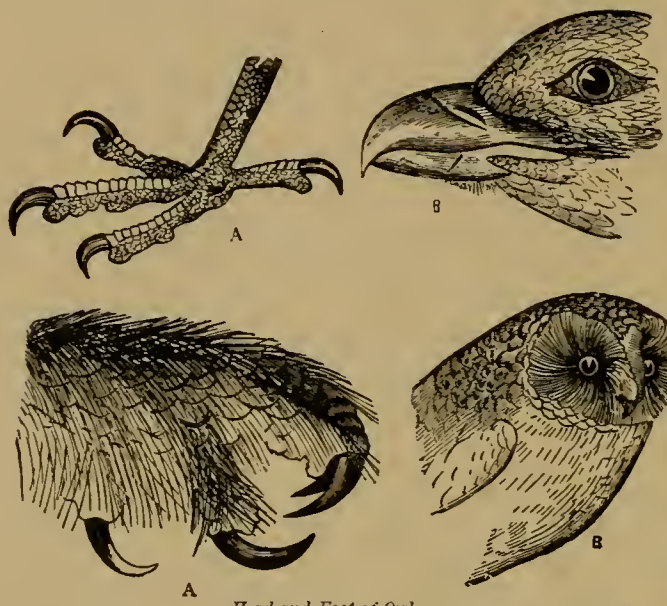
I.—The Skeleton.

SHOW from an illustration that the bones of the leg of a bird are arranged on the same plan as those of mammals, but in a considerably modified form. We find a *thigh* bone and *two leg* bones always present, though the smaller of the two latter is often but imperfectly developed. Then, in place of the ankle and foot bones, there is a single long bone called the *tarsus*. To the tarsus, which is commonly looked upon as the leg-bone, the toes are joined. The *toes* vary in number and arrangement, and in the number of joints in each. Generally there are *four*, of which *three* are in *front*, and *one behind*. (The ordinary position of the toes may be shown from the leg of a hen).

II.—How Birds Perch.—The special arrangement, by which most birds can sit and sleep on a branch or twig, is the most interesting and striking peculiarity in the structure of the bird's leg. All children will have seen how a canary *clasps* its perch with its toes, and will know in what position the bird sleeps. A boy can balance himself sitting on a branch, and he may "hold on" to secure his seat: but should he fall asleep he would be certain to get a fall of another kind. But when a bird sits down on a branch to feed, to rest, or to sleep, it cannot fall off if it would. The very act of sitting down makes the toes clasp the branch, whether the bird wills it or not. The arrangement is this: a flat, ribbon-like cord passes from a large muscle of the thigh over the knee-joint, and then winds over to the back of the leg, being kept in its place by a small muscular ring. It then passes down behind the leg bone, and over the back part of the joint of the leg bone with the tarsus, where it passes through a second muscular ring. It continues along the back of the tarsus to the junction of the toes, and then divides into cords which pass along under the toes.

By this arrangement, when the joints are bent as they are when the bird sits down, or when it raises its foot in walking, the cord is stretched, or pulled, and the toes are made to grasp without any effort on the part of the bird. The teacher may show this from the illustration, but a far more instructive illustration will be to show the actual working of the cords in the leg itself. Take a fowl's leg. Cut through the skin at the joint between the tarsus and the leg, and dislocate the joint with the point of the knife; a small pull will break the cord at its junction with the muscle in the thigh, and it will be drawn out as a soft, thick, but very strong white ribbon. Pull this cord, and the toes will close as if grasping.

Advantage may be taken of the specimen to show the scaly covering of the leg.

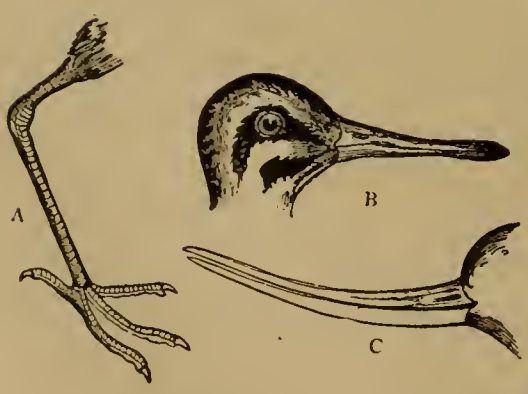


Head and Foot of Owl.

BIRDS OF PREY.

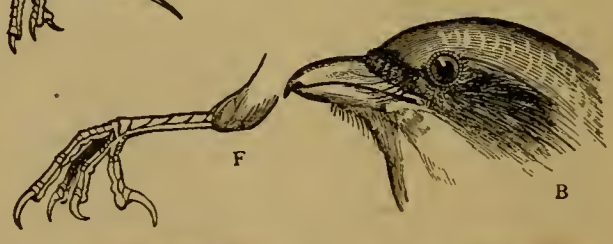
a. Head of Gray Goose. b. Foot of Domestic Goose.

SWIMMING BIRDS.



a. Leg and Foot of Curlew. b. Head of Snipe.
c. Beak of Avocet.

WADING BIRDS.



a. Head of Hoopoe.
b. Head of Red-backed Shrike.
c. Head of Swift-bellied Swift.
d. Head of Corn-bunting.
e. Foot of the Yellow Wagtail.
f. Foot of a Finch.

PERCHERS.

III.— Special Uses and Modifications in Structure.— We have now to consider the different duties which the legs have to perform, and the consequent changes in structure. All are used more or less in walking, hopping, or running; very many are used as supports during rest and sleep, and not a few are used as hands to hold the food while the beak cuts or tears it in pieces. (Refer to the black-bird, with an earth-worm, canary, with chick-weed, parrot, with nut, etc).

At the same time the special structure of the legs and feet of birds for special duties are sufficiently marked to enable us to arrange the birds in groups accordingly. Thus we have *Seizers*, like the eagle, *Perchers*, like the robin, *Climbers*, like the parrot, *Scratchers*, like the fowl, *Runners*, like the ostrich, *Waders*, like the heron, and *Swimmers*, like the duck.

LEGS AND FEET OF BIRDS.

I.— Seizers.—"Birds of Prey."— In this group the legs are strong, and the toes are furnished with strong, curved, and sharply-pointed claws, specially adapted for the capture of living prey of considerable size. The vulture, eagles, hawks and owls are all "birds of prey." The members of this group have four toes — three before and one behind; but the owls can place the outer toe of the three either in front or behind.

II.— Perchers.— This group includes the vast majority of the small birds which live in this country. They are also called *passeres* (*passer*, a sparrow). These birds for the most part spend the greater portion of their lives among the branches of trees, on which they perch, and hop from twig to twig. Their feet are specially constructed for this purpose. The toes are usually three in front and one behind, and the claws are sharp, but long and slender, and of sufficient strength to secure the bird firmly to its perch.

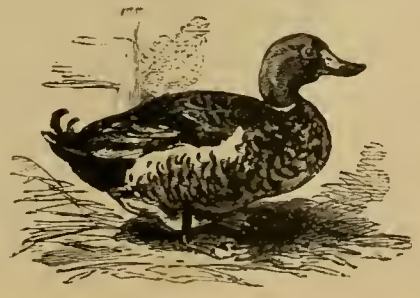
III.— Climbers.—All the birds in this group have *two toes before* and *two behind*. This enables them to cling with great tenacity to the branches of trees, or to climb up the perpendicular tree trunk. Parrots and woodpeckers are the chief examples of the group. Parrots climb rather by *clasping* small branches. Woodpeckers run over the bark of the tree trunk, and larger branches, in every direction by inserting their strong, sharp claws into any irregularities of the surface.

IV.— Scratchers.— Chiefly fowl and game birds. Show the leg of the fowl again in illustration, and point out that the legs of scratchers are strong, the toes rather short and thick, and the claws stout and strong and fit for scratching over the surface of the ground in search of food.

V.— Runners.— These birds depend entirely on their legs for locomotion, hence they are long, stout and strong. They never perch and few toes are required. In the ostrich they are reduced to *two*, and in the emu to *three*, and they are all pointed forwards. (The teacher may here refer to the speed of the ostrich, to an ostrich hunt, and to its manner of defending itself by kicking forwards).

VI.— Waders; or Stilt-Walkers.— These birds, of which the heron and crane are familiar examples, *wade* into the water after the food on which they feed, hence their legs are of unusual length. The length of leg has won them the title of stilt-walkers.

VII.— Swimmers.— This group includes geese, ducks, and sea-birds generally. The feet are specially constructed for swimming. (Show duck's foot). The legs are short and strong and placed far back on the body, and the toes are united by a stout membrane — the web.



EAGLE'S NEST.

NOTES OF LESSON ON

THE EAGLE.

Its General Appearance.— Show a picture or drawing of the eagle. By questions and statement set forth a clear and vivid *general description* of the bird. Its *great size;* the largest measuring three feet in length, and nine feet from tip to tip of the outstretched wings. Show these measurements clearly on table or large black-board, or the floor. Illustrate by comparison with size of the swan. Less bulky in body, but with larger stretch of wing and tail. It is one of the very largest flying birds. *Its beak*, curved, very strong and sharp, with a wide-stretching mouth; its *talons* or *claws*, four; three in front, one behind, sharp, very strong and curved. Its *eyes* bright, bold-looking, and large; its spreading *wings* and *tail*, the beautiful covering of *feathers*; large on wing and tail, smaller on body, all of them rich in color; different colors — brown, reddish, gray, white, black, golden-colored: making a soft, warm, light clothing for it.

Where, and How, The Eagle Lives.— The Eagle's Home.— Children who live in towns or where many people live together do not see eagles, unless it is one which has been caught and shut up in a cage. They live far away, where few people go; generally, where there are high hills, and great forests, or tall sea-cliffs. It usually makes its home on the top of a mountain. What is the home of a bird called? Describe the eagle's *nest*. Perched on the top of a high rock, reached only by a long, weary climb over rocks and hills, not often looked into by the eye of any man. *What made of?* Small branches of trees and bushes put loosely together. There the mother bird lays two or three large eggs; from these come the young, called *eaglets*. On a ledge of rock near may be seen the bones of *other birds*, even a *lamb*, or young *deer*. How came these there? They are the bones of creatures caught by the parent birds, and brought to the young as food. *The eagle is a bird of prey.* No other nest is near. No bird or animal lives near it. Even a man is in danger who goes near it. The eagle flies fiercely upon its foe, and strips and tears with its sharp talons and beak.

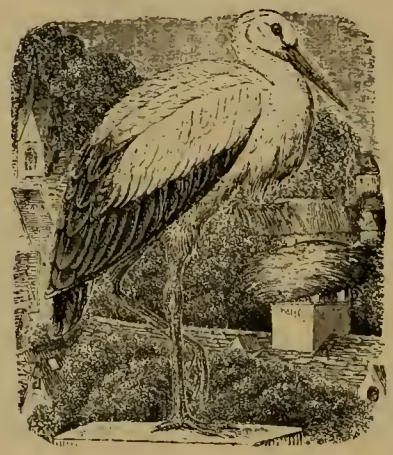
How The Eagle Gets Its Food.— Describe vividly the starting upwards from the mountain-top, rising high in the air, the circling flight, till almost out of sight, looking like a speck, though so large. But why does it fly so high? Can it find food there? No; but it can see over a wider space of ground, and so be better able to see where its prey is. Explain and illustrate how this is. But that it may see at such a distance, what kind of eyes must it have? Speak of its *keen, piercing sight*. Then how can it reach what it sees? Small animals run quickly out of sight; birds fly quickly away. Speak of the eagle's swift flight, the sudden drop, as of a stone out of the air. How does it seize its prey? The sharp talons; the strong, firm grip, the upward, darting flight should all be described.

Let questions of revision bring out the several points of structure which have been taught, and how they affect the eagle's habits; the swift strong wings; where they take the bird; why it goes there; the keen, piercing sight; the strong, sharp curved beak; etc.

Kinds of Eagles.— Eagles are of different sizes and kinds. The largest and finest is the *Golden Eagle*, so called because of the rich golden color of many of its feathers. Another is the *Sea Eagle* (Osprey). It lives on hills and cliffs near the sea and catches fish. It sees the fish swimming near the top of the water and drops down upon it from its great height in the air.

NOTES OF LESSON ON

THE STORK.



THE STORK.

A GOOD picture or drawing of the stork, and other similar birds will be required.

General Description.— By help of the picture go carefully over the chief points of structure. Here is a large bird. What is strange about it? Its long legs, long neck, long beak. Like other birds, it is covered with?—*feathers*. It has two legs, on each foot four long, sharp claws, three in front, one behind: the hinder one is always pointing backward, like the thumb when the hand is stretched out for *spanning*. It has also two wings; the feathers are long and pointed. The wings can be stretched out very wide. The head is round and small. What other bird's head is like it? *The head of the swan*. Where is the stork standing? Why is it standing there? *It is looking for its food*. Let us now learn about its

Parts or Structure.— The Body — large, roundish, covered with feathers. The color — black, or white. The *black* feathers cover the back, and the upper part of the tail; the *white* cover the breast, sides, and underparts.

The Neck, Head and Beak, or Bill.— The *neck* is long, tapering from body to head, like the swan's. The *head*, oval; eyes large, bright, round; on its upper part is a tuft or bunch of shortish black feathers. The bill *long*, very long, tapering, sharp at points and edges. How wide it can open! Show how it differs from bill of swan, goose and duck. These are flat and soft, and not sharp.

The Legs and Feet.— Point out the great length of the legs. They lift the body up a great height from the ground. They have no feathers, or only very short ones up near the body. The *feet and claws*. There are four toes, on each is a strong, sharp *claw*. Notice how they are placed — three before, one behind; how widely they spread apart when the foot is pressed on the ground

Where and How the Stork Lives.— It builds its nest sometimes in the tops of *great trees*, sometimes on *rocky hill-tops*. In some countries it builds as the swallows do with us, on the roofs, and in the chimney stacks of *houses*. But where does it get its food? They spread out their wide wings, stretch out their long necks and fly away to the marshes and plains, where pools of water are, and lakes, and ditches, or canal sides. Down they fly to the edge of the water. They do not swim, but walk on the muddy banks, and walk into the shallow water. What name is given to walking in water? It is called *wading*. So these birds are called *waders*. Why? What does the word mean? Other wading birds? *Cranes*, *Herons*, etc. (Show pictures of these). Why do they wade in the water? What are they doing there? *They are looking for their food*. Now we see the use of the *long legs*, and the *long neck*, and the *long sharp-pointed bill*. With their bright eyes they look keenly about. Soon they see a frog jumping to get out of their way. Down goes the sharp bill, the frog is snapped up, and swal-

lowed quickly. Next a little fish swims by; down again goes the long bill, and the fish is caught. So with large insects, sometimes great slugs or snails, even now and again a field mouse, or oftener still, a lizard.

Storks take great care of their young, and for this and for clearing away frogs and other small creatures they are much liked and cared for by the people in many places.

Where Found.— The stork lives in *France*, *Holland* and *Germany* during the summer, but migrates to Africa for the winter. Show these countries on a large globe.

Use.— To Eat up Refuse. — In many countries, particularly *Holland*, *Germany*, and *Egypt*, it walks about the streets, eating up the refuse it finds about. By this means the roads are cleared of foul substances, which would otherwise become very offensive and unwholesome. The Dutch treat it with much consideration, and enact laws for its protection.

Description.— The stork is a very large bird with long, thin legs, and a long neck and bill. It has toes partly webbed, and furnished with claws something like the nails of a man. The beak, legs and feet are red.

Kinds.— The White Stork.— This is the most familiar species. It is 3½ feet long and 4 feet high when it stands erect. Its general plumage is white, relieved by glossy black at the back of its body, and ends of its wings.

The Black Stork is similar in form to the white, but differs from it in color and habits. The upper surface of the body is of deep, glossy black, the under being white.

The Adjutant is larger than the former varities. It inhabits India and the East Indies. It measures as much as seven feet long. It has a large beak which is capable of seizing such animals as a full grown cat, a fowl, or a leg of mutton, and swallow it whole. The *head* and *neck* are destitute of feathers, and are covered with a reddish skin. The neck has a fleshy appendage like a pouch hanging from the middle of it. The back and wings are of a blackish-blue color, while the under part of the body is white, like its long, bare legs. It receives its name from its habit of frequenting the parade grounds.

From the picture bring out its general form. The long legs, neck, bill. What kind of a bird is the stork? Where and why does it wade? How does it catch the frog? What else does it catch? Other wading birds? Where does the stork build its nest? What kind of country does it live in? Any story remembered about the stork? How do people treat the stork? Why kind to it?

ANECDOTE.

A TAME STORK.

A gentleman in England has a stork, which, through kind treatment, has become so very tame that the bird never seems so happy as when in the society of the laborers who are employed on the farm, or in following the ploughman up and down the field.

During the haytime last year, the mowers had scarcely taken a stroke with their scythes, before the stork was at their heels, and he never left them until their work was done.

BLACK-BOARD OUTLINE.

I. Characteristics of the family.

1. Long, bare legs.
2. Slender bodies.
3. Long necks.
4. Long, pointed bills.
5. Short tail and long wings.
6. Four toes. Some have partially webbed feet.
7. Body covered with feathers.

II. Where found.

1. Marshes.
2. Edges of rivers and lakes.
3. Sea-shore.

III. Food.

1. Fishes.
2. Worms and insects.
3. Mollusks.

IV. Habits.

1. Build their nests of sticks, reeds and mud by the river, in old ruins, spires, and the tops of high trees.
2. Go from place to place in large flocks.

V. Use.

Feathers are used to trim hats.
Large wings to ornament rooms.
In this family we learned about the

Great Blue Heron.	*Crane.*
White Heron.	*Curlew.*
Stork.	*Golden Plover.*
Ibis.	*American Woodcock.*
Bittern.	*Flamingo.*

Compare the two families for resemblance and differences. Notice the peculiarities of each bird. These birds are found in New England, Southern States, Middle States and in parts of Europe.

NOTES OF LESSON ON

THE PIGEON.

WOOD PIGEON

DESCRIPTION. — By picture, and, where practicable, a specimen of a live pigeon, bring out first the general features, form, color, size, etc. Notice the pretty curve of the *head*, *neck*, and *shoulders*; the graceful *wings* and long tail; the beautiful, smooth, prettily-colored *feathers;* the slender *legs* and *toes;* the bright *eye;* the short, strong bill. Go again over each part with care.

THE HEAD. — Round, covered with smooth, short, close-fitting feathers; the *eyes*, round, bright, placed one in the middle of each side, towards the back of the head; the *bill*, the front part hard and horny; in the hinder part of the upper bill are the *nostrils*. What are they used for?

CARRIER PIGEONS.

THE BODY. — Roundish, bulky, covered with

smooth feathers; whitish usually on the breast and below; above, bluish, slate-color, dark, or even sometimes white.

The Wings. — Formed of long, pointed feathers. The quill-feathers, like those of the tail, are long and strong, so it has great power in flight.

The Legs. — Short, slender, covered with stout, parchment-like skin. The *toes*, four — three in front, one behind. They have strong, sharp nails, or *claws*, which can be used for

RING-DOVE

scraping up the earth. What other bird does this? Why does it scrape in this way?

Where and How the Pigeon Lives.— Where do we see them? These are generally *tame* pigeons. What does that mean? What kind of house is made for them? Speak of the large numbers often seen together. They live in *flocks*. What food do they eat? Where do they look for it? *Seeds*, *grain*, *peas*, young *shoots* of plants, *leaves*, etc. Notice how they drink. They dip their bills into the water, and take a long kind of sip or draught. Most birds take a little water into their bill, and lift up the head so as to let the water run down the throat. The sparrow drinks in this way.

There are *wild pigeons*. These live in woods, in this country. They are called *wood pigeons*. Describe the great numbers seen in flocks of wild pigeons. In some lands many thousands, more than can be counted. They make their nests in trees; in each is laid two eggs, from which the young ones come. Describe the *cooing* sound they make; the *rushing noise* made by their flight when in large numbers; the wonderful sight it is when the great flocks fly overhead in vast numbers from place to place.

The Flight of the Pigeon.— It is one of the very swiftest of all birds, and can fly very long distances with little rest. Speak of the carrier pigeons, trained to fly from far distant places to their home. Tiny bits of paper, with notes written on them, are tied under their wings. So in past days and even now they are made of great use to take messages in a short time over long distances.

The eggs, and the pigeon itself, are eaten as food.

Questions.— What pretty little bird is this? Is it wild? Tell me some story of a tame pigeon? How do they drink? What other bird drinks in this way? What is the carrier pigeon? How does the pigeon compare with other birds for swiftness? Are the eggs good for food?

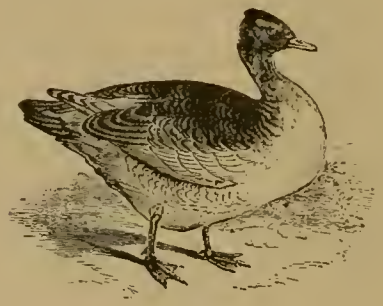
NOTES OF LESSON ON

SWIMMING BIRDS.

INTRODUCTION.— Show a drawing of some ducks, swans or other swimming birds.

Where Found.—Swimming birds are found in all parts of the world. There are many species which prefer cold countries, and migrate in summer time to colder regions.

Method.— Explain the words "*species*" and "*migrate*," and refer to the habits of the swallow.



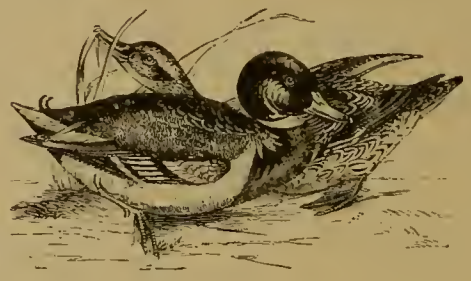
GOOSE.

Characteristics of Swimming Birds. — These are, *legs* placed far back on the body. *Feet* short, with webbed toes.

Covering consists of a very plentiful supply of feathers, saturated with oil and a thick coat of down next to the skin. *Bills* generally wide and flattish, also longer than their feet, to enable them to search for their food in the water upon which they swim. *Neck* in many instances long, *e. g.*, the swan.

Show how all the characteristics are necessary for their mode of living. Refer to drawings of the swan, duck, and other swimming birds. Show a duck's *foot* and *bill*. Children have seen a duck put its head under the water for food.

Kinds of Swimming Birds.— There are many kinds of swimmers, but we can only study a few now.



DUCKS.

Swans.— These are very elegant, with their long necks, beautiful feathers, and graceful swimming. They live chiefly on vegetable substances, and make rough nests with reeds, rushes and grasses, upon the banks at the side of the water. Their eggs are large, and of a dull, greenish white.

Geese.—The common gray goose is believed to have been domesticated from the European wild gray goose, or *Graylag*. There is also a beautiful species of white goose called the *snow-goose*, which is common in the Western United States in winter, and is a beautiful snowy-white, with the tips of the wings black, and the legs and bill red.

Ducks.— Some ducks have very pretty colored feathers. They live in this country, and are kept both for ornament and use.

USES.— For their flesh. For their feathers and down. For their eggs.

The Petrel and Sea-Gull.— These are sea-birds. They spend most of their time on the water, and prefer cold climates. They are found on our northern coasts. The Petrel or Stormy Petrel, as it is called, because its approach often foretells a storm, moves along on the top of the water, pattering with its webbed feet, and flapping its

wings. It received the name *Petrel* from the word Peter, because it walks on the sea. It is of a deep black color, with a few white feathers. It lays its eggs in a cleft of the rock, or in a rabbit burrow. It feeds on small fish, fat, or the refuse thrown from ships. It is often seen in *stormy* weather, because it can then easily secure its prey. As a means of defense it squirts oil in its assailant's face.

Questions.— Mention the names of some swimming birds. What is peculiar about their legs and feet that is not to be found in other birds?

Describe a swan; a duck. Are duck's eggs good to eat? Describe the snow-goose. What can you tell about the sea-gull? What bird spends most of its time on the water? From whence does it get its name?

Tell the story of the ugly duckling: how a swan was hatched by a duck, and was for a time despised by its foster-mother and brothers, but gradually it was transformed into a handsome swan.

NOTES OF LESSON ON

DOMESTIC FOWLS.

INTRODUCTION.— Call attention to a farmyard, and let children give the names of some animals kept in such a place. When they come to *fowls*, ask if any of the children have fowls at home. Show that we call those kept by people *domestic fowls*, just as we call our house-cat a domestic animal. The word *domestic* means belonging to the house. This class includes turkeys, geese, ducks and all birds which have the habit of scratching the ground in search of food.

Uses.— For Their Eggs.— These form a valuable diet, and if people have sufficient room to keep fowls, they will find that by careful attention to their food and houses they will secure a large profit.

For Their Flesh.— The flesh of young fowls is very sweet and tender.

For Their Feathers.— The small feathers may be used for stuffing pillows, etc.— The handsome feathers from the tail of the rooster are used to ornament hats.

Method.— Show some hen's eggs. Explain how nutritious they are. Ask who has tasted fowl, either boiled or roasted.

Description.— Among a number of fowls we notice the *rooster*, the *hens*, and the little *chickens*.

The Rooster is a handsome bird, with a very fine tail. He has his head crowned by a notched,

crimson, fleshy substance called a *comb*, and has two pendulous, fleshy bodies of the same color, hanging under his throat, called *wattles*. He is provided with a sharp horn or *spur* on the outside of his foot, with which he inflicts severe wounds.

The Hen is smaller than the rooster, and, except in the pure white breeds, less beautiful. She has a comb, but it is smaller, and less bright than that of the rooster.

The Chickens.— These are the babies. They come out of eggs, which the hen lays and sits upon. Her warmth brings the chickens to life, when they break their shells with their beaks, and come out. They have no feathers at first, but are covered with soft, yellow down. They follow their mother, who finds them food, and run under her wings for safety when they are frightened.

Method.— If possible show a large picture of each bird, and let children thoroughly examine it, noticing particularly the points mentioned. Show that this class of birds is distinguished by having a rounded, heavy body, covered with loose feathers, which sometimes on the neck assume the character of plumes; the wings are short, round, and concave underneath. These are not nearly so useful for locomotion as the legs; for short distances they fly tolerably well, but are more at home on the ground. The legs are very strong and firm and the tendons of the muscles are of a bony nature. The structure of the beak should be noticed, and a real foot and beak should be shown.

Describe the claws, which are extremely hard, and particularly suited to the bird's mode of living, enabling it to dig and scratch up the earth in search of its food, which consists principally of seeds, roots and insects.

Habits.— Houses. —Some fowls are very valuable, and great care is taken in raising them. They must have a warm, dry, well-ventilated house. It must be provided with shelves furnished with baskets or boxes formed along the walls. These should be lined with straw ready to receive the eggs and form the nests. The house must have a yard or run attached to it, where the fowls may get air and exercise during the day. The floor of both house and yard must be kept dry and clean. The house must contain perches.

Food.— Fowls must be well fed. In farmyards they can run freely about, and pick up for themselves, requiring then only a little hand-feeding. Waste house-scraps may be mixed with their grain. They must have fresh green vegetables, as grass, cabbages, etc., also some mortar or shell rubbish, from which egg shells are made.

ROOSTER AND HEN

Character.— The rooster is very courageous; he struts about at the head of the hens as though ready to protect them from danger. The hen is generally timid, but when she has a brood of chickens will fiercely attack any enemy. She takes great care of her little ones.

Questions.— What is the meaning of the word *domestic?* Why do people keep fowls? What are they good for? What are the young fowls called? For what are fowls' feathers used? How do the chickens look when they first come from the shell? Tell about some chickens you have seen. How does the hen differ from the rooster? What do fowls require for food? Can they fly well? Describe the claws? Give some other description of their habits.

NOTES OF LESSON ON

LEGS AND FEET. (Mammals.)

(Any leg or feet bones will be useful, especially those showing the joints. Diagrams of limb-bones,)

INTRODUCTION.— Explain the word mammal, if not already explained: almost all mammals have *four limbs*. [The hind limbs of the whale are not developed.] In man the *fore-limbs* are arms and hands; in monkeys, all the legs have hands; and in bats, the fore-limbs become wings; but in the great majority of cases the limbs consist of *legs* and *feet*. In this lesson we consider the limbs of man, because they are always taken as the model with which to compare others.

The Parts of the Limbs. — The children to name the parts, and the motions of the joints: and the teacher to call attention to the *general correspondence* in the parts of the two pairs of limbs, and their motions.

Thus the *arm* and *thigh*, the *fore-arm* and *leg*, the *wrist* and *ankle*, the *hand* and *foot*, the *fingers* and *toes*, all correspond generally in situation and form. Then as to motions, the *arm* and *thigh* can be moved in almost any direction from the shoulder and hip, although the motion of the arm is more extended; the *elbow* and *knee* allow of but one movement, viz., backwards and forwards; the *wrist and ankle* move pretty much like the knee and elbow, but have some power of motion in other directions; the *fingers* and *toes* have the same number of joints, with power of motion in the same direction, except that the thumb has other motions. Both fingers and toes have nails.

The Bones. — Draw attention to the diagrams of the bones of the arms and legs. Give the bones their common names and arrange on the black-board.

Arm and Hand.	No. Bones.	Leg and Foot.	No. Bones.
Arm,	1	Thigh,	1
Fore-arm,	2	Leg,	2
Wrist,	8	Ankle,	7
Hand,	5	Foot,	5
Four fingers,	12	Four toes,	12
Thumb,	2	Great toe,	2
		Knee-pan,	1
	30		30

Joints. — Elicit from the children that without bones we could not stand, and without joints we could not move. Then call attention to, and illustrate more fully, the varied movements permitted by the joints; and on this classify into ball-and-socket joints, and hinge-joints. Show next how that the bones would slip out of joint were they not tied together in some way. Secured by strong white cords, or *ligaments*, passing from the cup to the ball, or from bone to bone.

The Muscles, Nerves, Blood-vessels, and Skin. — Explain very generally the uses of these. The muscles are organs of movement. They are stretched from bone to bone, and by their contraction move the bone on the joint. Illustrate with the biceps muscle, which raises the arm on the elbow-joint. Within the muscles are nerves and blood-vessels; the latter bring nutriment and take away waste; the former are organs of feeling, and they further serve to carry messages from the brain to the muscles, directing and guiding their movements. The skin is a protecting covering over all.

Uses. — We have now to consider the chief purposes *(functions)* which the legs and feet are called upon to serve in the animals which suckle their young, and the modifications consequent thereon. We use different kinds of tools for different kinds of work, and so it is with ani-

mals. The cow is not fitted for climbing trees, nor the monkey for running a race on "all fours." On the other hand a monkey in a tree, a seal in the water, and a bat in the air, are as active and graceful in their movements as they are awkward and ungainly on the land. Thus, while the general plan of structure, as described in the last lesson, is ever retained, the details are so modified as to form tools fitted for very diverse purposes.

The great function of the limbs is of course locomotion; but then the locomotion is very variable in kind. One animal has to make its way among the branches of trees, another on the ground, another in the air, a fourth through the water, a fifth through the soil, and so on. And for each purpose the same tools are used, though so modified as outwardly to resemble new tools altogether. By a few questions the teacher will be able to elicit that the chief modes of progression, in addition to the more ordinary *walking* and *running*, are *climbing*, *flying*, *swimming*, *burrowing* and *jumping*.

ELEPHANTS' AND HORSES' FEET.

Walking and Running.

In ordinary walking and running some animals plant the whole sole of the foot on the ground, while others walk and run on their toes. In the latter case the foot seems to form another leg-joint. Look at the legs of the cat, for example. In the fore-leg the elbow is seen not far from the body, and the wrist appears as another joint lower down. In the hind leg, the knee is seen to correspond with the elbow, except that of course it points forwards, while the heels show lower down as a reversed knee. What particular purpose does this special organization serve? A cat-like tread is a common expression. It refers to the silent, stealthy footstep of the cat, brought about firstly by walking on the toes, and secondly by the beautiful, soft, leathery pads beneath the toes. Walking on the toes gives a lightness and springiness to the movement not otherwise obtained. Most of the land *carnivora* walk on their toes. Horses, cows, sheep, deer, camels, elephants, and many of the smaller common animals walk on some modification or other of the toes.

CAT'S FEET.

Climbing.

A foot like ours is but little use for climbing, and so in monkeys the feet are shaped like hands, with fingers and thumbs on all, and the monkey is said to be *four-handed*. Some monkeys travel more by making long jumps from branch to branch, catching by the hands, than by climbing with "all fours." Now if you watch a boy suspend himself from a bar, you will note that he always keeps his thumbs side by side with his fingers, and not opposite to them, as he does in holding a walking-stick; and so in the monkeys referred to, the thumb is placed side by side with the fingers and cannot be opposed to them.

Other mammals beside monkeys climb trees — the squirrels, rats, and some of the cat tribe, for

instance. The body of the squirrel is not sufficiently bulky to require very strong hands for support, nor are its paws sufficiently large to grasp branches of any size, so the legs are short, and the nails are changed to long, curved, and sharp claws, which secure a strong foothold even upon the upright tree-trunk. A curious modification of the hind-leg of a rat enables it to descend perpendicular walls with great ease. The foot is so articulated at the ankle, that it can be turned halfway round and the claws pointed backwards. The animal can thus hang from its hind-claws head downward. The sharp, strong claws, and powerful bones and muscles, enables some members of the cat tribe to climb the trunks of trees, and secure themselves among the branches.

Flying.

The only mammals which fly are the bats. Refer to picture of skeleton to show that the bones of the wing correspond with the bones of our arms and hands; but that the wrist and finger-bones are developed to an enormous extent. Then from a picture of a bat on the wing, show how a thin membraneous skin is stretched over and between the bones, the whole forming a very efficient flying apparatus.

Swimming.

Some of the mammals which live in or frequent the water, prey on fishes. Now fishes propel themselves by means of the tail-portion of their bodies with lightning-like velocity through the water, and the mammals must have their limbs so modified for swimming purposes as to render their possessors equal or superior to the fishes in quickness of movement. Whales, dolphins, and porpoises have their bodies shaped like that of a fish, the fore limbs are merely fins for balancing, or for holding their young during suckling. The hinder limbs are absent altogether, and a broad tail-fin placed at right angles to the body of the fish is the organ of locomotion. [Illustrate this, and compare with tail-fin of fish.] Seals too have their bodies tapering like a whale, but unlike the whale they possess *four* limbs. The toes of the feet are *webbed* like those of the duck, and form very efficient oars. The broad, webbed feet, flippers as they are called, placed close together, form a tail of great power in swimming. The bones of the fore-legs are very much shortened and thickened, and little more than the webbed toes are visible outside the body. On land, seals hobble about in a very ungainly fashion; but in the water they are all grace and power. The hind feet of the otter, the polar bear and the beaver are flat and expanded, and the toes are webbed like those of the seal. They are used as paddles.

Burrowing.

The fore-feet of the mole afford the most striking example of digging organs. The bones of the arm are shortened and strengthened. Those of the hand are enormously large in comparison with the size of the body, and are furnished with strong, sharply-curved, and flattened claws. The paw itself is set on the fore-arm rather obliquely for greater freedom of movement in burrowing, and the whole limb is furnished with powerful muscles.

Jumping.

The jumping mode of locomotion is best illustrated by the kangaroo, though many other animals, notably the jerboas and the hares, proceed in a similar manner by a series of bounds on the hind-limb.

In the mole, the fore-limbs are much enlarged. In the kangaroo it is the hind limbs which undergo an extra enlargement. The fore-limbs are small and feeble, and the hind limbs alone are used in progression. The animal uses these with such effect that it covers more than a dozen feet at a single bound, and continues these long jumps for a considerable length of time without appearing to tire. In the hare again the hind limbs are very much longer in proportion than the fore-legs, and the animal "shoots along over the ground by a series of long leaps, with great swiftness." In the jerboas the development of the hinder limbs is seen perhaps in the greatest degree: some of them can spring from twenty to thirty feet at a bound.

FIG. 1.—AGGAGEERS HUNTING AN ELEPHANT.

NOTES OF LESSON ON

THE ELEPHANT.

BLACK-BOARD PLAN.

I. DESCRIPTION.
- a. *General description.*
- b. *Special study of the trunk and its uses.*
- c. *Age of elephant.*

II KIND OF ANIMAL.
Mammal — proboscidian.

III. KINDS OF ELEPHANTS. { *African.* *Indian.*

IV. WHERE FOUND.

V. CHARACTER OF THE ELEPHANT.

VI USES OF THE ELEPHANT.
- a. *Indian.* { Beast of burden and of draught. For hunting the tiger. In warfare. Ivory.
- b. *African.* { Food. Ivory.

VII. HUNTING THE ELEPHANT.

Description.—The elephant is the largest land animal of the world. It is usually from seven to nine feet in height. The largest are about twelve feet high, fifteen feet long, and weigh seven or more tons. Jumbo, whom the children of our

country and of England used to be so proud of, was not quite twelve feet high. Although the elephant is such a huge animal, we must not imagine he is anything like a whale in size. It would take five or six elephants standing one in front of another to equal a whale in length. The head of the elephant (See Fig. 3) is of great size and very strong. In a wild state he can pull down trees with it. He has large, flapping ears and bright, rather small eyes. The sharp teeth in the front part or our jaws and the jaws of other animals are called incisors, a name which means to cut. In the elephant, the incisors of the upper jaw are developed into long, tapering tusks (See Fig. 1) which increase in size as the animal grows old. They are very hard and white and are the ivory of which such beautiful ornaments and other things are made. The most remarkable thing about the elephant is his trunk. You may be surprised to learn that it is really his nose.

His upper lip and nose are drawn out or elongated into this conical tube, called a trunk or proboscis. The lower lip is triangular and forms a cavity into which the trunk can easily be thrust. The neck is necessarily short to sustain the weight of the heavy head. The body is thick and slopes towards the tail. The legs must needs be short and strong to support such an enormous body. Notice how stout they are. They look like the trunks of trees. The feet are immense and have each five toes. They are about half as large round as the animal is high, so if an elephant is twelve feet tall he will make a track about six feet in circumference. (The children can form some idea of the size of Jumbo's foot by tying a piece of crayon to a string a foot long and representing with it a circle on the floor) The skin is thick, dark and wrinkled, and has almost no hair upon it. You have perhaps heard of white elephants. They are made so by disease. White is not their natural color.

Trunk. — The elephant's trunk is so wonderful we will study that a little more. In a large animal it is as long as a tall man. It has a cut-off appearance at the end, or is truncated as we say. In this end you see the openings into the two nostrils (Fig. 2), which are long canals running entirely through the trunk into the head. The nostrils communicate with the head by two other holes which the elephant can open and close at will. For this reason he can fill his trunk with water and squirt it over himself or over others, as he sometimes does in sport, or when he is displeased. He is fond of swimming and can cross broad rivers.

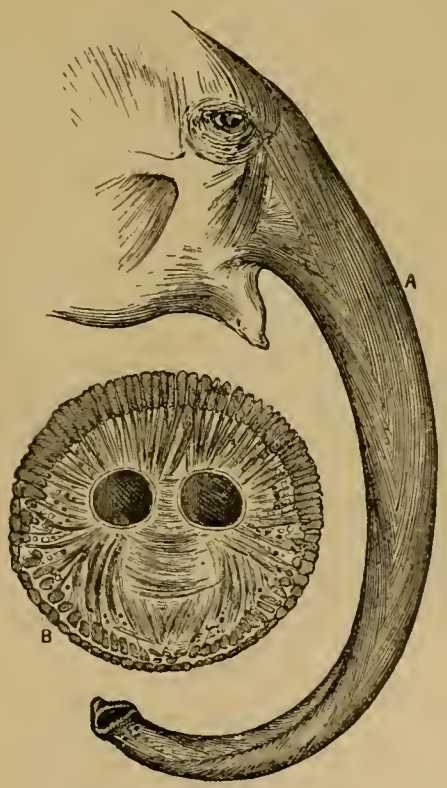


FIG. 2. — TRUNK OF ELEPHANT.
a. Muscles and Tendons. *b*. Transverse Section.

When he is swimming, the tip of his trunk only is visible above the surface of the water. It is kept there to enable him to breathe. Looking at Fig. 2 you see that at the extremity of the trunk there is a small part five or six inches long, which looks something like a finger. It bends so easily, or is so flexible and also so sensitive, that with it he can pick up a small object, fire off a pistol or uncork a bottle. He does so many things with this

and his trunk that the people of India call him by a name which means "the beast with a hand."

Use of the Trunk. — The food of the elephant in a wild state is herbs and the leaves of trees and shrubs. His neck is so short that he cannot get his mouth to the ground as the cow does, and other animals that feed upon herbage. Neither can he reach with it the foliage upon the branches above his head. The trunk, like its small finger-like part, is very flexible; so it can move up, down, sideways, or even roll up in a ball, (Fig. 2). The elephant can also lengthen and shorten it when he pleases. With it can he pull up a tuft of grass and carry it into his mouth, or pull down tall trees and strip the leaves from them to eat. Closing his nostrils at the upper end, he can fill his trunk with water and discharge it into his mouth to quench his thirst. We see, then, that one use of the elephant's trunk is to enable him to eat and drink. In fact, if it were injured so that he could not use it, he would soon die. Nor is this all. It is his principal means of defense. He can twine it about an enemy and toss him into the air, or hurl him to the ground and trample upon him, or rend him with his tusks.

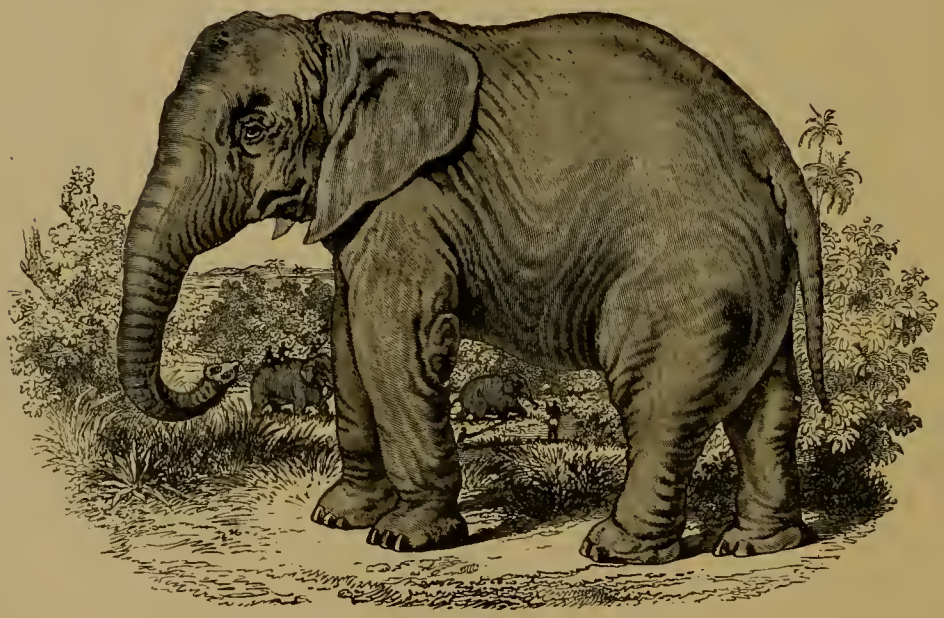


FIG. 3. — AFRICAN ELEPHANT.

But the elephant is naturally a gentle, kind animal and does not usually injure very seriously even an enemy, except in self-defense, or when very much enraged.

He sometimes fills his trunk with water and squirts it over his body to cool himself. With it he can in the same way throw dust over his back and sides to keep off insects.

When very warm and annoyed by flies, he occasionally takes a branch of a tree and fans himself. With his trunk he makes a peculiar sound called trumpeting, because it is a shrill tone something like the blast of a trumpet. The elephant is aware

of the importance of his trunk and when he is in danger raises it high above his head to keep it out of harm's way. He does this when hunting the tiger, so that it may not be injured by that animal.

Age. — Elephants reach a great age. It is supposed that they live to be a hundred and fifty or two hundred years old.

Kind of Animal. — The elephant nurses its young, and is therefore a mammal. It has five toes on each foot, instead of two, as the camel has, some of these are protected by hoofs, so he might be called an ungulate, and he is sometimes so called, but more often another name, on account of his proboscis is given him. He is called a pro-bos-cid-ian.

Kinds of Elephants. — There are two kinds, the African, so called because he lives in Africa and the Indian found in Asia. They are very much alike except that the African is the larger and has monstrous ears (Fig. 3) which reach below the head. They are sometimes five feet long and four feet wide, and are used by the natives for shields. Both males and females have tusks, while the Indian female does not. Four of the toes on each front foot and three on each back foot are provided with hoofs: Indian elephants have hoofs on all the front toes and on four toes of each back foot. Jumbo was an African elephant, as can be seen by his picture. His tusks were just beginning to grow when he was killed. (Fig. 1).

Where Found — The elephant is a great eater. For this reason he must be where food is abundant. Jumbo ate each day two hundred pounds of hay, sixty-four quarts of oats, a barrel of potatoes, ten or fifteen large loaves of bread and several quarts of onions, besides all the cake and peanuts the children gave him. A large elephant drinks between two and three barrels of water daily. They also take frequent baths. You see then that elephants must live where there is plenty of water and an abundant vegetation. It is very warm and rains a great deal within the tropics. For this reason plants grow fast and large there. The elephant, like the camel, finds his home in the Old World, but nearer the equator, in the forests and jungles, south of the desert regions. The African is found everywhere in the interior of the continent where there is food for him. He used to live as far south as Cape Colony, but has been driven from that section by white men. The Indian elephant is found (see map) in India, Burmah, Siam and the Islands of Ceylon, Sumatra and Borneo.

Character of the Elephant.— The elephant, unlike the camel, is docile and patient. He becomes attached to man. Jumbo was never happier than when a dozen children were upon his back and he was giving them a ride. Of course elephants are sometime cross and dangerous, but so are dogs and cows. They are likely to grow ugly with age. In such cases, their masters keep them in subjection by prodding them. That is, they tie the elephants up and goad them with a sharp pointed instrument called a prod. The elephant bears it as long as he can. When he finally decides to submit and be good, he gives a kind of squeal which is his way of saying that he gives in. He will then behave quite well for a time.

Uses of the Elephant.— An animal so strong, so gentle and so easily trained is very serviceable to man. Formerly both the African and the Indian elephant were tamed, but now the Indian elephant only is domesticated. Attached to a plow he will do the work of twenty oxen. There is one difficulty, however. He is such an enormous eater that it costs a great deal to keep him. As he can lift heavy weights, he is employed in making bridges and in the erection of large buildings. He is useful in carrying stores where roads have not been made, and for dragging artillery, and for piling timber, etc.

The African elephant is used for food by the natives. Except the trunk, the tongue, the heart, and the feet, his flesh is not considered very good eating by white people, but the negroes like it. He is especially valuable on account of his ivory, as his tusks are large, sometimes weighing 150 pounds. Ivory is worth rather more than a dollar a pound, so an elephant's tusks are very valuable.

It is said that 25,000 elephants are put to death every year for their tusks. Ivory is used for handles of knives and brushes and for ornaments. The Chinese make the most beautiful articles of it. The English use a great deal of it in the manufacture of knives.

Hunting the Elephant. — The Africans hunt the elephant in a rude way. Sometimes they dig a pit-fall in his path to some stream of water, and fasten a sharp-pointed stick at the bottom, which pierces him, and prevents his escape.

Sometimes the elephant-hunters, or aggageers, of the Hamran tribe in Africa use swords for killing elephants. They follow the tracks of the animal, so as to arrive at their game between the hours of 10 and 12 A. M., at which time it is either asleep or extremely listless, and easy to approach. Should they discover the animal asleep, one of the hunters would creep stealthily towards the head, and with one blow sever the trunk while stretched upon the ground; in which case the elephant would start upon his feet, while the hunters escaped in the confusion of the moment. The trunk severed would cause a loss of blood sufficient to insure the death of the elephant within about an hour.

Elephants are usually found in herds of from ten to thirty, led by one old elephant called the patriarch, which directs them and defends them. The East Indians sometimes spend several weeks in capturing a herd. Around an open place in the jungle they build a high, strong fence of bamboo with one small opening in it. Surrounding the herd, they gradually drive them into the path leading up to this enclosure. In this way they are assisted by the tame elephants, which coax the wild elephants into these pathways.

BLACK-BOARD OUTLINES.

SUGGESTIONS.

a. With the aid of pictures, all under "matter," except the illustrative stories, can be taught by questions. If possible, draw upon the board those that you can represent easily: and use others found in books. (You can get a stencil of an elephant.) If you have not a piece of ivory, some child in the school may be able to procure a specimen for the class to see.

b. If the children are much interested and you have time to do so, follow this lesson with a short one upon extinct elephants, taking up especially the Mastodon and the remains of elephants found in our own country, the Mammoth; and the ivory of Siberia.

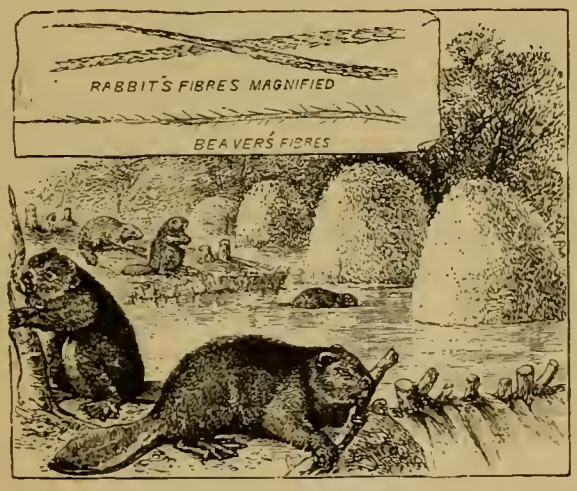
c. To make the exercise a profitable language lesson, let the children reproduce both orally and in writing.

— ELVIRA CARVER.

NOTES OF LESSON ON

THE BEAVER.

GENERAL DESCRIPTION. — Procure a picture of the beaver, and, if possible, a piece of its fur. Show the picture, and in the usual manner bring out, by question and description, its shape, covering, parts, etc. Its round body, sharp-pointed head; thick, soft, close-growing fur, dark-brown or chestnut color; especially its strangely-shaped tail and its webbed feet. How strange the latter are! What bird has a webbed foot? What does the duck use it for? The beaver, too, is a swimmer? Notice the kind of tail, covered with markings and rough, scaly skin, a little like that of a fish.



THE BEAVERS AT HOME.

Where and How the Beaver Lives. — Describe its home in and near the rivers and lakes of cold northern lands. They live many together, and may be seen swimming in the water. What helps them to swim? Sometimes running about on the banks, even climbing the trunks of trees. The curious dwelling they build; the cutting of the branches of trees with their sharp, chisel-like teeth. They are *gnawing animals*. What does that mean? Name other gnawing animals? Rabbit, mouse, rat, are all gnawing animals. The shape of their teeth, and the way in which they are used, are the same in all these animals. Speak of the clever way in which they gnaw off the branches of the trees, and push them through the water. They push them together so that the ends of the trees and boughs stick in the mud, they bring mud from the bank and heap it on the branches of the trees, and build a kind of wall with them. Describe the curious look of the houses in which they build, the tops of them showing above the water. They make passages from one part to another, and live there through the cold winter months. They are very timid and shy, and cannot endure the presence of man. When frightened they dive into the deep water, and swim quickly away. Give other descriptions of their habits.

NOTES OF LESSON ON

THE FOX.

GENERAL DESCRIPTION. — By aid of a good picture, drawing or stencil outline on black-board, bring clearly out the general features of structure and appearance. Its *name;* general likeness to the *dog; size, color; nose sharper*, and *bushier tail* than the dog's; *lithe, active, strong-looking.*

The Head.— Erect, tapering; ears standing straight up, pointed; eyes bright, keen-looking, set forward; month open wide, showing two rows of strong, sharp-pointed teeth; neck, longish, stout, standing straight up from shoulders, so as to lift the head well above the body.

The Body.— Long, large deep chest, giving plenty of breath, so enabling it to keep on running for a long time; covered with thick-growing, yellowish-brown, softish *hair* or *fur*. The Tail.— Straight, bushy, tipped with white. Make very clear the distinctiveness of the bushy tail, sometimes called the *brush*.

The Legs.— Stout, strong-looking, feet thickish; its four toes, each having a strong claw, not sharp as the cat's is. How does the cat keep its claws sharp? The fox cannot draw its claws in, so they get blunted by running over the stones and earth.

Where and How the Fox Lives?— Ask if any have seen a fox, and where? Children living in the country may have done so. They will tell where it may be seen. So bring out that the fox is a *wild animal*. It lives in woods, getting into a hole in the earth. Sometimes it lives in a hole in the stump of an old tree. Its young ones are sometimes so found. What is the food of the fox? It feeds on the *flesh of other animals*. It catches living creatures. *The fox is a beast of prey.* Describe its cunning, crafty ways of hunting them: its stealing at night into the poultry house or farm-yard; catching poultry, rabbits, young birds, even mice and frogs, if it can get nothing better. It is quick in hearing, smelling, and seeing, so is difficult to catch.

Kinds of Fox and Uses Made of Them. — The fox of our land is called the common fox. In very cold lands lives the Arctic Fox. It is smaller than the fox of this land. Its fur or hair is white or bluish-gray, very thick, long and soft; its feet and legs very hairy. Why does it need such a covering? It is caught in traps and snares for the sake of its fine fur. The skin is very valuable, and is used for trimming cloaks and dresses. The people living in the cold northern lands sometimes eat the flesh of the fox.

Questions.—What animal does the fox resemble? In what points does it resemble the dog? What sort of a tail has it? What is the tail sometimes called, and by whom? Is the fox a wild animal? Since it catches and feeds on other animals, what is it called? In what way are foxes used for sport? For what are its tendons used?

ANECDOTE.

A gentleman, who was a great hunter, once had a beautiful fox, which he had kept for some months, intending to use him for sporting purposes. After a time, the animal learned to know his voice, and would allow no one else to go near him, so a sort of kennel was made for him in the loft of the stable, and the gentleman would visit him every day and bring him food.

One evening he returned late at night from a journey which had kept him all day from home, and taking a lantern, proceeded to the stable to see if the fox was all right. He found him crouched at the foot of the steps which led to the loft, and although he manifested great pleasure at seeing his master, yet when he attempted to ascend the loft, the fox immediately ran in front of him, snarling and showing his teeth, and using every effort to prevent his going up.

On lights and help being procured it was discovered that some of the upper flooring had given way, leaving a formidable hole, through which, if the gentleman had gone up with no other light than the dim lantern, he would undoubtedly have fallen through, and perhaps have been seriously injured. It is gratifying to know that the hunter never allowed that fox to be chased by his dogs, but kept him for years, so that after a time he used to follow him around the grounds like a dog.

THE LEOPARD.

NOTES OF LESSON ON

THE LEOPARD.

INTRODUCTION. — Show pictures or black-board drawings of a tiger and a leopard; let children notice the most striking likenesses and differences; tell the name of the smaller animal.

Where Found.—The leopard abounds in Africa and Southern Asia. Show these countries on a large globe; let children tell where lions and tigers are found.

Size.— He is smaller than the tiger, measuring about three feet from nose to root of tail, with a tail of two feet, three inches, and standing somewhat more than two feet high. Compare with the picture and with the size of a large dog.

Covering.— He has a beautiful skin, the fur of which is yellow on the upper part and white on the under parts, breast, and inside the limbs. It is marked with black spots; those on the head, neck, back and limbs being of various sizes, irregularly dispersed, while those on the sides are large, consisting of small ones arranged in circles. There are ten rows of these spots.

Shape.— His form is particularly graceful and elegant.

Head.— This is smaller in proportion than that of the tiger; it has small erect *ears*, bright *eyes*, and very sharp *teeth*, like all the cat tribe. His *whiskers* are long and white.

Legs.— These resemble the tiger's, and have the same padded feet with retractile claws.

Tail.— Long and round, gets more slender towards the end.

Compare his structure with that of the domestic cat.

Home.—He lives in the forests, where he loves to climb the trees and catch the monkeys and other tree-loving animals.

Food.— His prey consists of antelopes, hares, monkeys, sheep and cows. He is sly and crafty, as well as strong and fierce, and by stealth will gain admission into poultry-yards, and with one swoop destroy all the fowls roosting therein. The leopard seldom attacks man, and when he does so, it is by stealth. If pursued, and brought to bay, he will fight with much ferocity and courage. The Africans make much of those warriors who have killed a leopard.

Movements.—The leopard is extremely agile; it can run, leap and climb well. Compare and contrast with *lion*, *tiger*, etc.

Character.— Leopards are fierce and bloodthirsty, crafty and sly. They may be tamed, but can never be entirely trusted. They lay up provisions for the future.

Methods of Capture.— The leopard is sometimes shot, but is generally caught in pitfalls, which are slightly covered with branches of trees, on which pieces of meat are placed.

Tell any other anecdotes that you may know, to illustrate the leopard's habits.

One small species of leopard is called the *cheetah*, and is tamed and used for hunting in India. There is also, an animal called the *leopard cat* found in these same countries, and in the East Indies, which is small, like the cat, and spotted like the leopard, thus combining the two animals.

The *panther* is regarded by some as a species of leopard, though of larger size, with large ring-like spots, the centre darker than the color of the body.

Questions.—Its size? Shape? Covering? How it may be known? By its *spots*. A beast of prey covered with stripes? What animal in this land is like the leopard? In what is the cat like the leopard? How does the leopard catch its prey? What animals are caught by it? Where does the leopard live?

THE POLAR BEAR.

NOTES OF LESSON ON

THE POLAR BEAR.

INTRODUCTION.— Show a picture or stencil drawing of a Polar bear, and ask children its name.

Use.— For its Fur.— This is used by the inhabitants of its native land to make clothing, and by us to form rugs for carriages or rooms.

General Description.— The white or polar bear is a very large, powerful animal. It is about nine feet long from the nose to the tail, and stands four feet high. It has an extremely thick covering of silvery-white fur, tinged with yellow.

HEAD.— Small for the size of its body, roundish with a pointed nose. Its ears are small.

NECK.— Long and extremely powerful.

BODY.— Like all the bears, it has a large, heavy body.

LEGS.— Longer than those of the other bears.

FEET.—It has soft, padded feet, each having five toes, furnished with strong claws, slightly curved. Their color is black and so they form a great contrast with the white fur that falls over the feet. The bottoms of its feet are covered with longish hair, which prevents the animal from slipping

on the ice. Their claws are not able to be drawn in like the cat's.

Method.— Compare the length of bear with some part of the school-room, also the height of bear with another part. Explain that it has such a thick covering because it lives in very cold regions.

Let children look at the picture, and say what kind of a head it has. They will notice that it has a gentle, pleasing countenance.

Teacher will show pictures of some other bears, and let children notice that they all have large, heavy bodies. They continue to grow until they are twenty years old, and even after that they increase in bulk. Still the Polar bear does not get as heavy as some bears do, but is very swift-footed.

Compare the neck and legs of this bear with those of other bears.

Where Found.— Polar bears love icy-cold regions. They are found on the shores of North America, and are sometimes caught on pieces of floating ice, which come southward. When kept in shows they appear to suffer greatly from the heat, and if ice be placed in their cages they will roll upon it with great satisfaction.

Method.— Explain that they are called Polar bears because they live near the Poles; the most *northerly* and *southerly* points of the globe. The children may point out the *Poles* on a good-sized globe. Describe the nature of this bear's home, covered with ice and snow: the same color as the bear.

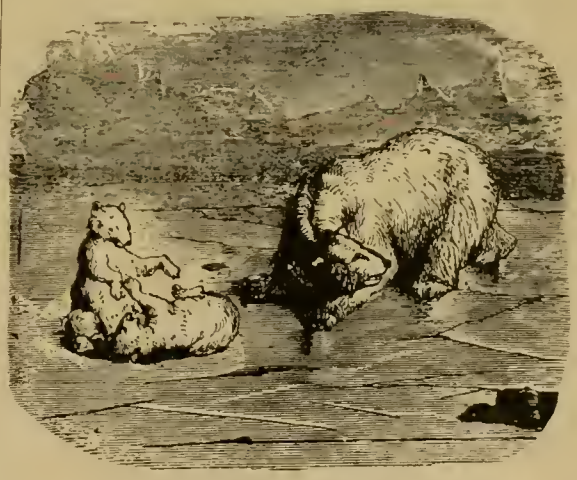
Food.— This bear, unlike other bears, lives entirely upon flesh. Its principal food is dead whales, seals, salmon, and other fish. They are good swimmers, and can catch both seals and fish very cleverly.

Homes.— They live on the sea-shore, and seek shelter under an ice rock, or burrow amid the snow. The build themselves a house in the snow for the winter.

Winter Sleep.— Like all bears, they sleep through the winter, requiring no food, and yet retaining their strength and size.

Young Ones.— The young bears are called cubs; they are born during the winter. The mother has two at a time, and is strongly attached to them. When they first leave their home in springtime they are about the size of shepherd dogs, and are nice and fat.

Character.— When hungry they will attack a man, but at other times are not so fierce or formidable. The mother will fight fiercely in defence of her young.



Method.— Describe the manner in which the bear catches seals and fish.

Compare the homes built by the Polar bear with those built by the Esquimaux.

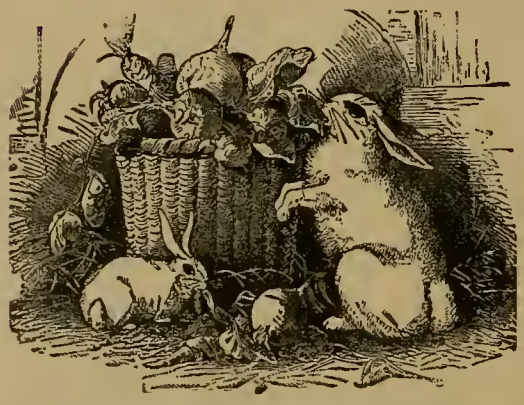
Show a picture of some cubs.

Tell one or two anecdotes of bears, particularly one illustrating their love for their young.

Questions.— What is this gentle looking animal called? Why called *Polar* bear? Is it like the bear we see sometimes in this country? What are the young bears called? What animals do they resemble?

NOTES OF LESSON ON

THE RABBIT.



A BLACK-BOARD drawing of the rabbit will be needed, or, even better, when judiciously used, a living rabbit may be employed with advantage for illustration.

General Description.— First show the picture or specimen, and speak in general terms of the chief points of structure — its pretty appearance; its soft, furry covering; the bright, large eye, long ears; its gentle timid nature, so easily frightened when wild, running off to hide itself as one gets near, etc. Then speak of *where* and *how it lives*. Children often see rabbits as kept in their homes or the homes of neighbors. These are *tame*. Why so kept? They are pretty to look at and easily attended to. From them we may learn something about—

Wild Rabbits.— Children living in the country often see them. Where should we look for them? *In fields and woods*. Early in the morning, or as evening comes on, they may be seen running in the grass, or in the fields. They are busy cropping the grass, munching the turnips, sometimes getting into the gardens. What they seek there. What their food is. The mischief they often do by eating the young crops, etc. How pretty they look; how watchful they are; how quick to see, to hear, if we go near, or if any noise be made how quickly they scamper off. They are all soon out of sight. Where do they go? They run into *holes in the ground*. Describe how they scrape away the earth with their strong feet and sharp nails at the end of the toes. The long, underground *burrow;* a number of these winding paths near together make a *warren*? What, then, is a warren? What is a burrow? How is the burrow made? Explain that these are dug usually in loose, sandy soil, though sometimes made in the earthy parts, among rocks and stones.

Form and Parts of a Rabbit.— By help of picture and specimen describe *size and general form*. Round head; shortish, round body, small upturned tail; the four legs, the *hinder longer* than the two *fore legs;* the covering of soft, warm, brownish-gray fur, etc.

The Head, round, moving quickly on the short, thick neck; the *eyes* large; where placed, standing well out. Why this is, what it enables the rabbit to do; the long ears, how they hang; their quick motion, and reason of this; the mouth and teeth; show clearly the four front teeth: two above, two below, shaped like sharp *chisels;* their *nibbling* action, how used, other animals like them. Bark of trees, young wood, turnips, grass, etc, all *nibbled* in the same way.

Body and Tail. Describe again. Different appearance when running, sitting, etc. The covering. Difference of color in wild rabbits and many tame ones; the later often *white*, *black*, or *spotted*, or rich brown color.

Feet and Legs. Shape, four toes on each foot, ending in the strong nail; use of this in burrowing.

The rabbit is timid, caught in traps, or shot; their flesh is used for food, and the skin for cheap furs, etc. Many birds, and beasts of prey also eate

the rabbit and feed on them. The quick sight and hearing and running, enable the rabbit often to escape from danger.

The hare belongs to the same family as the rabbit, and although resembling the latter in many points, may be easily distinguished by having a longer head and ears; the ears with a black tip, and the upper surface of the tail has not that brown color found in the rabbit. It does not hide in burrows like the rabbit, but trusts to its great speed to elude its numerous enemies.

Questions.— Have we any use for rabbits? Why do we keep them sometimes? Have you ever seen one? Is the rabbit a fierce animal?

HARES.

GROUP OF APES AND MONKEYS AND A LEMUR

NOTES OF LESSON ON

THE MONKEY.

GENERAL DESCRIPTION. — Show a good picture or drawing of the monkey. Use it throughout the description to illustrate the various points referred to. Describe in the usual way its general form and appearance. It is more like a man than any other animal is. Call attention to its head, body and limbs. It has two arms and two legs. At the end of each arm is a hand. Some have a thumb as well as fingers. How is the thumb of our hand put? At the side of the fingers, but we can move it opposite to them. Some monkeys have no thumb. What is at the end of the leg? At first it looks like a foot. It is really more like the hand. So the monkey is four-handed. We use the foot only for walking; we use the hand for holding or grasping. The monkey grasps or holds with its four hands. Note next its covering. It is *hairy*. The larger kinds are covered with *stout*, *coarse* hair. The smaller with *soft*, *silky* hair, more like fur. Look next at the face and head. The nose and the

mouth are stretched out, and somewhat pointed. Many are more like the nose and mouth of a dog than of a man. The monkey has a *tail*. There are kinds of monkeys without a tail. These have a different name. They are called *apes*. What is the difference between a *monkey* and an *ape*? The monkey has a tail. The ape has no tail.

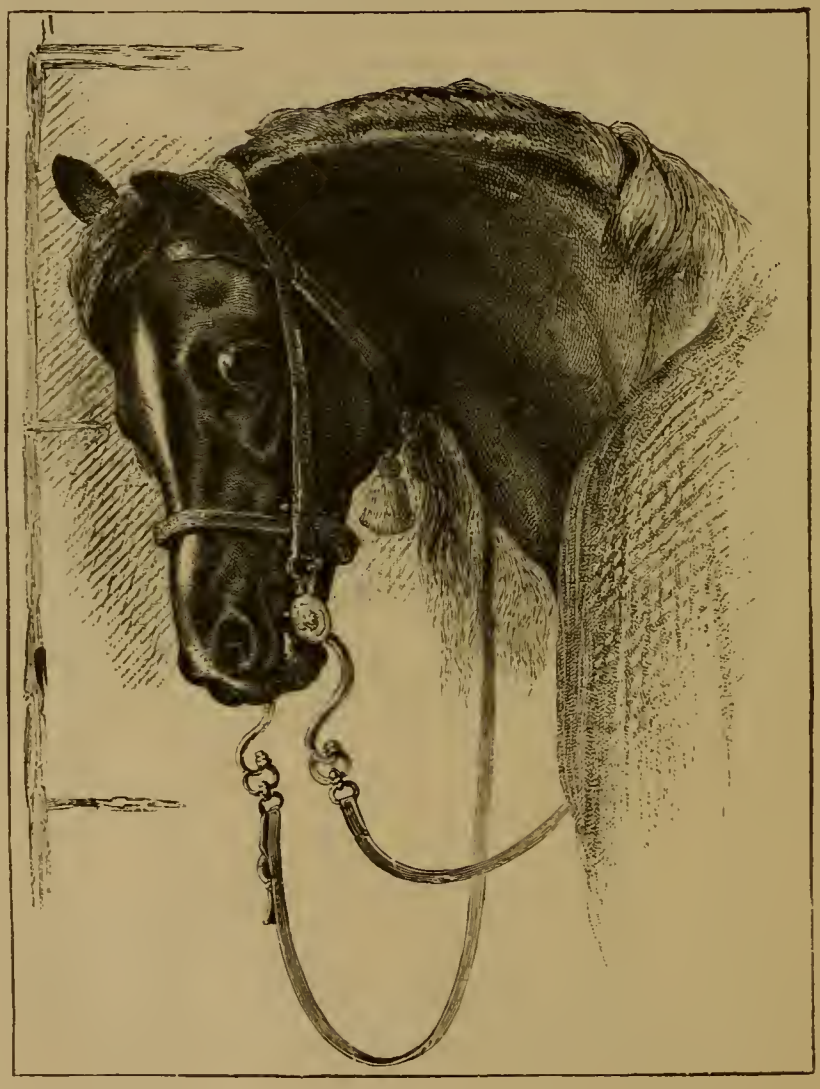
Where and How Monkeys Live.—Their Ways. — Most of the children have probably seen a monkey. Ask where. What it was doing, etc. From this teach that the home of the monkey is in far-off lands. They live in hot countries, only in different parts of the world. They may have seen a monkey climbing and jumping actively about. This will lead to a description of the monkey in its own home. Picture vividly the great forests; the large numbers of monkeys to be seen in the boughs and at the tops of the trees; their *quick* and *active* movements: the wonderful jumps they take from one branch or tree to another; the strange noises they make; their funny, mischievous ways; the curious ways they have of imitating what they see, etc. They hold fast to the branch by their hand, and swing from bough to bough: some even twist the end of the tail round a branch and swing by it.

Lemur. — The lemur is a species of monkey, but of small size, having a sharp muzzle like the fox, and large eyes. They feed upon birds, insects and fruit. Are mostly found in Madagascar and the neighboring islands, one species particularly in Africa, the cat lemur being about the size of that animal, and another the size of a mouse.

Kinds of Monkeys. — There are monkeys which live always in the trees, seldom coming to the ground. Others live chiefly on the ground, among the rocks and hills. Some are large and strong and fierce; others are small and gentle, and playful in their ways. Some walk on all their hands, as dogs and horses do on all their feet.

Their Food. — They eat the fruit, leaves and twigs of many different sorts of trees and other plants. They climb the tall cocoa-nut trees and take the nuts. Also the dates from the date palm. Some also eat insects, the eggs of birds, etc. They get into the rice fields and amongst the sugar-canes, and do mischief in many ways in the gardens and fields which may be planted near their homes.

Questions. — What animal is most like man? In what way does it resemble us? Have you ever seen a monkey? What are its habits? Food, etc.? Are they mischievous? In what ways?



NOTES OF LESSON ON

THE HORSE.

INTRODUCTION.— Refer to what the children see and know of horses as seen day by day. In towns and cities the great numbers seen, drawing carts, wagons, carriages, etc. All are at work. They differ in *size*, and *strength* and *color*. Which kind of work will need the strongest? Why? Which needs the quickest? Note the difference between the stout, strong *cart-horse*, the more slender *carriage-horse*, the delicate *race-horse*. How strong the horse is! How fast and long it can run. Yet it is *gentle*, and generally *quiet*. It will not harm a child. On its feet are iron shoes. Why are they there? How are they fastened? Why do not the nails hurt its foot?

Description of the Horse.— Show pictures of horses. Describe and elicit its general *shape*, *size*, *appearance*. The large long *body*, the wide *neck*, the large long *head*. Its *legs* strong and firm. The horny *hoof*, the *mane*. Where placed. The *tail*, when left to grow as it will, long and bushy. Sometimes it is cut short. The *ears* pointed and movable. It can hear quickly. The *eyes* large; placed high. It can see a long way. The *nostrils* wide; it can smell quickly. In the mouth are the *teeth* and the *tongue*. The front teeth are long and sharp. Between them and the back teeth is a large space. Here is where the *bit* is placed. What is it made of, and its use. The back teeth are broad and sharp. With the front teeth it *cuts* its food; with the back it *grinds* it. What is the body covered with? The *hair* is short, soft, close, of different colors. The horse can *walk*, *trot*, *gallop*. The differences of these?

Its voice is called *neighing*.

Habits, Food, etc.— There are *wild horses* in some places. These live many together, as sheep and cows do. Such a number is called a *herd*. What other animals live in herds? What is a number of sheep called? In most lands all horses are *tame*. They are kept for the work they do. What food do they eat? *Grass*, *hay*, *oats*, *turnips*, *etc*. What one name may be given to these? *The horse feeds on vegetables*. Other tame animals which do so? Other wild animals? Name some that feed on flesh. What is the place called in which the horse lives? In the stable are a *rack* for hay, a *trough* for corn, a *pail* for water, *straw* to lie upon. The young horse is a *colt*; when very young a *foal*. Horses are named according to the work they do. There are *cart-horses*, *carriage-horses*, *race-horses*, *etc*. In all times and places men have made use of the horse.

Think of the many ways in which they are of use. In the *country*; in *town*.

Use When Dead.— The *skin* is made into leather. For this it has to be *tanned*. The *hair* is used for stuffing *cushions*, *chairs*, and *sofas*.

The long hair of the tail is woven into horse-hair cloth. Its *hoof* makes glue. The *fat* for soap. The *bones* for knife-handles or burnt for manure.

Revision.— Let the horse be the subject for the next composition exercise, the children, meanwhile, finding out all they can about horses. When practical, they may illustrate their compositions with an outline drawing of a horse. Memory Gems will also be in order.

—N. S. EDWARDS.

"A man of kindness to his beast is kind,
But brutal actions show a brutal mind;
Remember *He* who made thee, made the brute;
Who gave *thee* speech and reason formed *him* mute.
He can't complain, but God's all-seeing eye
Beholds *thy* cruelty, and hears *his* cry:
He was designed thy servant, not thy drudge:
And know that *His* Creator is *thy* Judge."

—ANON.

COW AND CALF.

NOTES OF LESSON ON

COWS.

INTRODUCTION.— Show pictures or black-board drawings of cows and let children give name. After this show others of the tribe — *zebu*, *buffalo*, *bison*, *yak* and *musk ox*, and tell them that all these animals belong to one family and are much alike in uses and habits, though they live in different parts of the world.

Where Found.— Some animals of the cow kind are found in every part of the world. We have the *ox* and *buffalo*. The *zebu* lives in *India*, *China*, and *Eastern Africa*, the *yak* in the mountainous parts of *Central Asia*, and the *musk ox* in the extreme north of America. Show these countries on a globe or map.

Size.— All the animals of this family are large in size, except the yak and musk-ox. Our own oxen reach a very large size, but are surpassed by the buffaloes.

Covering.— Most of those animals are covered with short hair. In our own cows the color may be white, brown, black, or mixed. *Bisons* and *buffaloes* are dark brown or black, with a lot of long hair around the head and neck; the *zebu* is a pale gray or cream color; the *yak* has long, black hair, that on the hump, mane, and tail being nearly white; the *musk ox*, who lives in cold regions, has a high mass of wooly hair of a yellowish-brown color.

Body.— The bodies of these animals are large and heavy, several species being furnished with humps, *e. g.*, the *zebu*, *bison*, *buffalo* and *yak*.

Legs.— Generally speaking, the legs are short and thick, with cloven hoofs.

Head.— This is large, with fine, fierce *eyes*, and *horns* of different shapes, those of the bison and buffalo being very formidable. The *neck* is usually short and thick.

Food.— All the animals of the ox tribe eat grass and other vegetables, chewing the cud as described in the lessons on "*Ruminants.*" The domestic cattle are fed on hay, turnips, carrots, etc., in the winter time.

Character.— These animals are naturally fierce and courageous. When wild they are, especially the buffaloes and bisons, very formidable, but when tamed become most useful to man.

Uses.— As a class these animals stand first for usefulness. One member of the family at least is found in nearly every country, where its uses are much like those of our own species, the domestic cow. Its uses are:—

To Give Milk.— This is abundant, rich and nourishing.

To Labor.— In many parts oxen are still used to draw the plough or wagon.

To Provide Food.— Its flesh furnishes us with one of the most savory and nourishing of our animal foods.

To Give Horn.— Which furnishes material for making the handles of knives and forks, and many other things.

To Give Hide.— Its skin or hide is thick, and makes most durable leather.

To Furnish Glue.—This substance is made from its hoofs, ears, and hide parings.

To Give Hair.— This is used to mix with plaster for building.

To Furnish Animal Charcoal.— This is obtained from its bones.

Questions.— What do we get from oxen? Which of the oxen family is most useful? To what class do oxen belong? And to what tribe? How do they rank with other animals in point of usefulness? Tell some anecdotes of a cow? Of a buffalo? Where does the zebu live? Which is the larger animal, the bull or the buffalo?

HIPPOPOTAMUS.

NOTES OF LESSON ON

THE HIPPOPOTAMUS.

INTRODUCTION.— Show a picture or drawing of the animal, and ask or tell its name. Let the children look at a picture of the elephant, comparing and contrasting the two.

Where Found.— The hippopotamus lives in Africa, being found near large rivers, *e. g.*, the *Nile*, the *Niger*, the *Gambia*, and also near the large lakes. Children find these rivers on a map of Africa. Describe the nature of the country, particularly the luxuriant vegetation on the banks of the rivers.

Uses.—Its large canine teeth, or tusks, are very valuable for making artificial teeth because the ivory does not turn yellow.

Its Flesh,—is eaten by the inhabitants of Africa. The fat resembles lard, and the choice morsels are the feet and the tongue.

Its Skin,— being very thick and tough, is used by the natives for making shields, and by the inhabitants of Cape Colony for making whips.

Compare with the uses of the elephant.

Structure.—The average size of these animals is five feet high and eleven feet long, but large ones are sometimes seventeen feet long, seven feet high, and sixteen feet round the body.

Covering.— The skin is very thick and of a dusky color; it is thinly covered with very short, whitish hairs. The pores of the skin exude a thick, oily fluid, which keeps the animals from taking cold in the water.

Appearance.— The hippopotamus in figure slightly resembles an unwieldy ox.

Head.— This is large, with small *eyes* and small, pointed *ears*, a very wide *mouth*, containing very large *teeth*, and having thick, broad *lips* furnished with tufts of short bristles.

Body.— This is large and bulky.

Legs.— Short and thick, with large *feet*, having four toes encased in hoofs.

Point to the different parts of the animal as they are named, and make children notice them well; compare and contrast with corresponding features of the elephant. Compare the *lengths* given with familiar objects. Explain the word *compressed*.

Habits.— The hippopotamus is amphibious in its habits, and is sometimes called the *River Horse*. It spends most of its time in the water, is an admirable swimmer and diver, can sink at will, and walk along the bottom of the lake or river.

Its sleeping place is generally a muddy island overgrown with reeds.

It has an enormous appetite, and subsists entirely on vegetable food. On the banks of the Nile he sometimes tramples and eats whole fields of grain and sugar-cane.

The hippopotamus make a squeak when young, but when grown his voice is loud and terrible.

On account of the great weight of his body, and the shortness of his legs, he cannot run fast, but takes to the water on the approach of danger.

Character.— The *strength* of this animal is enormous, but its *disposition* is mild, and gentle except under great provocation. He has been known to bite great pieces out of boats, and to raise one containing six men and throw it into the air. These animals are gregarious, collecting in herds of twenty or thirty.

Means of Capture.— By Peas.— The Egyptians throw a quantity of dry peas in their way. The animals eat them, and drink a quantity of water, when the peas swell and cause the death of the creatures.

By Traps.— They are sometimes caught in pitfalls, or by injuring their feet upon spikes driven into boards for that purpose.

By Harpooning.— This is common in Africa, but is dangerous.

THE INDIAN RHINOCEROS

NOTES OF LESSON ON

THE RHINOCEROS.

INTRODUCTION.— Show a picture of the rhinoceros, contrast it with those of the elephant and hippopotamus, and tell its name.

Where Found.— The rhinoceros lives in India, Java, Sumatra and Africa. Let children find these places on the globe; explain that they are all warm countries.

Description. — SIZE. — A full-sized animal stands rather more than five feet high. Though they are not very tall, they have large, powerful bodies like the elephant and hippopotamus.

COVERING. — The rhinoceros is covered with a remarkably thick skin, which lies in heavy folds around the neck, shoulders, and hind quarters of the Asiatic species.

HEAD. — This is somewhat long in shape, with the upper lip hanging over the lower. This lip is capable of considerable extension, and is slightly prehensile.

Some species have two horns, while others have only one. They are of peculiar formation, growing on the skin, and being composed of a fibrous, horny substance, as hard as iron.

The eyes are very small, and the animal has defective sight.

The ears are erect and pointed. The senses of smelling and hearing are both very keen. The legs are short and thick. The feet possess three toes each, encased in hoofs. The tail is slender, flat at the end, and furnished at the sides with very stiff, black hairs.

Habits.— Home.— Their favorite haunts are swamps and marshy plains, where they wander solitary, seldom in pairs. They love to roll in the soft mud, because it kills the insects which get

under the folds of their skin, and annoy them very much.

Food.— The appetite of these animals is gluttonous. Their food consists principally of herbs, particularly the succulent roots, which they dig up with their horns.

Character.— The rhinoceros is quiet, if undisturbed, but when roused, furious and formidable, the elephant himself being hardly an equal antagonist. It is supposed to be the *unicorn* mentioned in the Bible, and possesses all the rage, untameableness, swiftness, and strength ascribed to that animal. The Asiatic species are capable of being tamed, and are sometimes ridden like the elephant.

Uses.— The chief use of this animal is to supply *leather* for making shields. Its *flesh*, which resembles pork, is sometimes eaten, and in Java it has been trained to bear a saddle, and to be ridden.

Kinds. — Indian Rhinoceros. — This has one horn, short, and thick, with its skin in very heavy folds.

Javanese Rhinoceros. — This species is found in Java, Sumatra and Borneo. It is distinguished from the Indian one by its smaller size, and its lesser skin folds. Its horn is shorter, and its legs longer, and more slender.

African Rhinoceroses.— There are four chief species in Africa, two being *black*, viz., the *Borele* and the *Keitloa*. Both have two horns. In the former, the second horn is longer, and bent backwards, while in the latter, both horns are of considerable and nearly equal length. The skin has no heavy folds, and both are very savage, dangerous animals. The two *white* species are larger than the black ones, and *have long* horns.

Questions.— The rhinoceros belongs to what species of animals? What disposition has it? What does the word *prehensile* mean? Describe the head and horns of the rhinoceros. How many kinds are found in Africa? Describe them.

Gordon Cumming, in his "Hunter's Life in South Africa" gives the following details of the rhinoceros:—

"Both varieties of the black rhinoceros are extremely fierce and dangerous, and rush headlong at any object that attracts their attention. Their horns are much shorter than those of the other varieties, and finely polished with constant rubbing against the trees. The horns are not connected with the skull, being attached merely by the skin, and they may thus be separated from the head by means of a sharp knife. They are hard and solid throughout, and are fine material for various articles, such as drinking cups, mallets for rifles, handles for tools, etc., etc.

The eyes of the rhinoceros are small and sparkling and do not readily perceive the hunter, provided he keep to leeward of them. The skin is extremely thick, and only to be penetrated by bullets hardened with solder.

Both varieties of the black rhinoceros are much smaller and more active than the white, and are so swift that a horse with a rider on his back can rarely overtake them.

The white rhinoceros attains an enormous size, feeds solely on grass, carries much fat, and their flesh is excellent, being preferable to beef. They are of a much milder disposition and more inoffensive than the black rhinoceros, and rarely charge the pursuers. Their speed is very inferior to that of the other varieties and a person well mounted can overtake and shoot them.

The head is a foot longer than that of the *Borele;* they generally carry their heads low, whereas the *Borele*, when disturbed, carries his very high.

Unlike the elephants, they never associate in herds, but are met singly, or in pairs.

PRAIRIE DOGS.

NOTES OF LESSON ON

THE TORTOISE.

SHOW a picture or black-board drawing of a tortoise, and ask or tell its name.

Kinds.— The name tortoise includes several different species, some of which live on land and some in water All have an outer framework of shell. Some that live in water are called *turtles*.

COMMON TORTOISES — found in ponds, lakes, or marshy grounds.

TERRAPINS — which live in water, generally rivers.

HAWKSBILL TURTLE — so called from the shape of the mouth, lives in the warm America and Indian seas.

GREEN TURTLE — so called from the color of the fat.

Shell.— The shell of the hawksbill turtle is used to make combs, handles for pen-knives, boxes, etc. It is called *tortoise-shell*.

Flesh.— The flesh of all tortoises is eaten, though that of the turtle is considered the richest. The flesh of the *land tortoise* is eaten in the *Grecian Isles*. A famous soup is made of turtle's flesh.

Eggs.— Turtles lay their eggs on the shore. They are about the size of the hen's, but have no shell. They are agreeable and nutritious.

Size.— Very various. Some *land tortoises* are from *one foot* to *five feet* long, and from *five inches* to a *foot and a-half* across the back. *The tortoise* is small — about *ten inches* long. *The green turtle* is found as large as *seven feet* long, weighing from *seven* to *eight hundred pounds*. The *hawksbill turtle* is not so large.

Structure.— The shell of this reptile is composed of bones, which are thus placed outside its body instead of inside. The head, neck, tail, and four feet project. Most of these can be drawn in at pleasure. They have no teeth, but a horny substance instead. The shell of the land tortoise is arched, and so strong that a team may pass over it without doing it any injury. The terrapins have webbed toes.

Habits.— FOOD.— The *land tortoise* is a vegetarian, eating grass and various plants, including lettuces, of which it is very fond. It will drink milk. It lives to a great age. Some of the other tortoises eat flesh, but the *green turtle* feeds on seaweed at the bottom of the ocean.

One kind of *tortoise* lives to a great age. It has a curious voice, not unlike the mewing of a cat. It is fond of warmth, and if kept in a house will love to sit on the hearthrug in front of the fire. If kept out of doors it will burrow under the mould at the end of autumn, and wait there until the warm days of spring. It does not like rain, and whenever a shower comes it will hide itself, and with retracted head and limbs wait until the rain ceases. People keep this kind of tortoise as a pet.

Questions.— Can you tell me anything about the tortoise? What does the name include? Mention some of the tortoise species, and the reason for their names. What are turtles? What are they good for? Describe the voice of the tortoise?

NOTES OF LESSON ON

THE RAT AND HIS RELATIVES.

MOST children will have seen a rabbit, a rat, a mouse, or a squirrel in the act of feeding, and may possibly have noticed the large front teeth with which these animals *gnaw*. Now all the animals in the world — and there are an immense number — which have *four* large, front teeth, suitable for *gnawing*, like the rat or the rabbit, are included in one great *group* and called *rodents*, viz. : gnawing animals. The *rabbits*, *squirrels*, *rats*, *mice*, *beavers* and *prairie dogs*, are chief members of the group living in this country. Their chief foreign relatives are the *marmots*, *hamsters*, *lemmings*, *jerboas*, *porcupines*, and the *chinchillas*.

Teeth of Rodents.— The rodents may and do differ very much in other particulars, but in the structure and use of the teeth they are all alike. The teacher will no doubt be able to show the teeth, if not in the living animal, at least in the skull and jaws of a rabbit. The teeth are of two kinds only, the *grinders* and the *cutters*.

The surface of the *grinders* presents a rasp-like appearance, from the plates of enamel, which stand up in ridges above the softer dentine.

The *cutters*, or *incisors*, are *four* in number, *two* above and *two* below. They are strong, sharp *chisels*. Mice can gnaw through boards, rats have been known to cut through leaden pipes, and beavers cut down trees. Unless some special provision were made, teeth used in this way would soon get blunt and useless. To prevent this the outer or front surface of each tooth is covered with a thin plate of very hard enamel, while the other part of the tooth is made of bony matter, and is much softer. As the tooth is used the bony matter wears away more quickly than the enamel, and the latter is left as a thin cutting edge. Yet another provision is necessary. The carpenter's chisel wears away in time, and so would the rodent's tooth ; but for the fact that just as fast as it is worn away above, it grows and is pushed up from below.

It is necessary also for the purpose of gnawing that the lower jaw should be so jointed to the upper as to allow of motion *backwards* and *forwards*. The food, cut into slices with the front teeth has to be ground with the molars ; hence the jaws have a second, a *grinding* motion, like the cow or the horse.

Other Common Features.— All rodents have *feelers* in the shape of whiskers, like the cat. [Question on and point out their uses.] The feet usually have *five* toes, armed with claws, some of which are sharp, curved, and pointed for climbing, the others blunt and strong for burrowing. The number of toes is sometimes reduced to *four*, or even *three*, on the hinder limbs. In the mouse family there are *four* toes on the front leg, and *five* behind. In the great majority the fore-paws are used to some extent as hands. [Instance squirrel with nut.] The majority of rodents are

nocturnal, and burrowing animals; and many of them hibernate.

Special Points in Structure or Habit.— Rat.— The foot of the rat is jointed so loosely to the hind limbs that it can be turned half way round, and the claws pointed backwards. [Show how this assists the animal to ascend perpendicular walls, etc.]

Harvest Mouse.— This, one of the smallest of quadrupeds, in addition to specially long, flexible toes, has a prehensile tail. She climbs grass and corn stalks with facility. In descending she twists her tail round the stem and *slides* rapidly to the ground. This mouse builds a very pretty nest about the size of a cricket ball, and suspends it from stout grass or other stems.

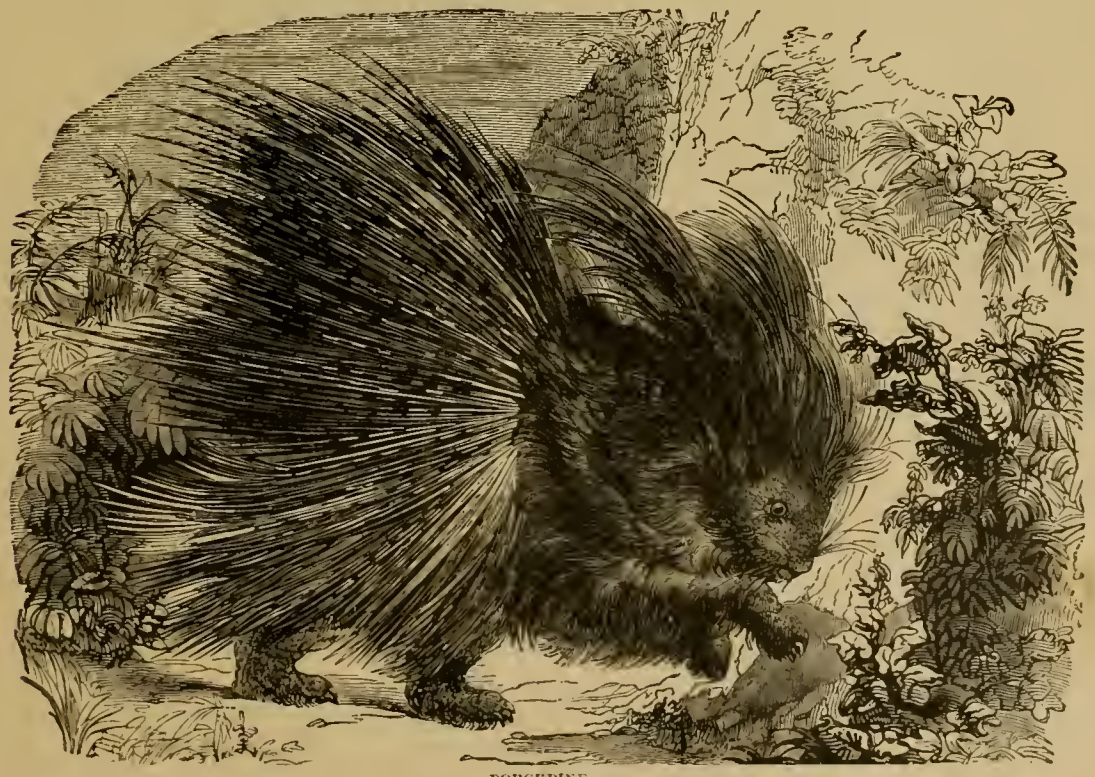
Flying Squirrel (so called.)—These squirrels have a fold of the skin stretched along the sides of the body, and attached to the legs almost to the feet. When the squirrels take their long flying leaps this skin is stretched to its utmost extent and gives considerable support in the air. [Compare with an open umbrella pulled against the wind.]

Beavers have the toes of the hind feet webbed, and converted into paddles, for swimming purposes. The tail is large and scaly, and flattened above and below.

The *Jerboas*, and the *Jumping Mice*, have long and strong hind legs and feet, on which alone they travel, like the kangaroo.

In the *porcupine* long spines take the place of ordinary hair.

Uses.— The rodents are most valuable for their fine, warm furs, and millions are destroyed every year to supply the market. The most valuable skins are those of the squirrel, rabbit, hare, musk-rat, beaver, chinchilla.



PORCUPINE

FROGS.

NOTES OF LESSON ON

THE FROG.

(The teacher should, if possible, secure a specimen. It may be kept on the table in a small wire cage, with a sod of grass for the floor. A picture of skeleton, and, failing in the living specimen, a picture of the animal itself, will be necessary.)

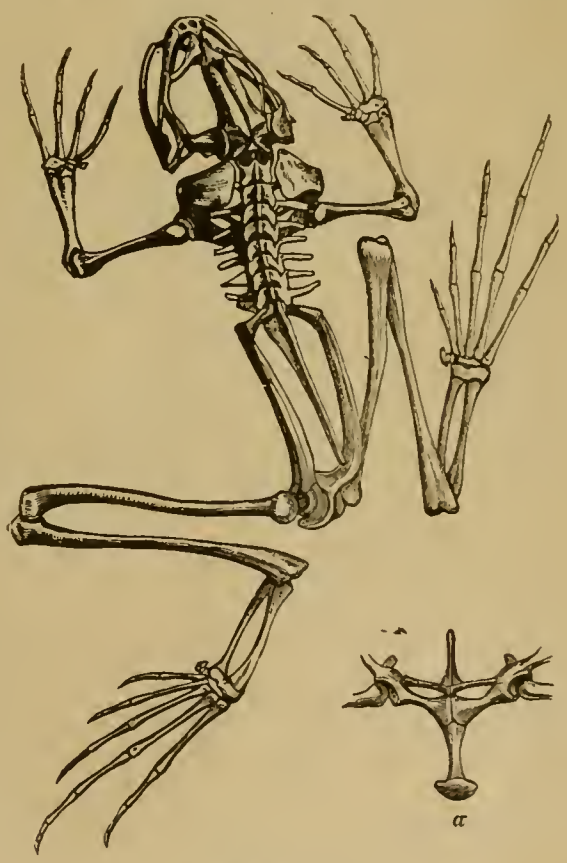
GENERAL APPEARANCE.— Were it not for its associations, it is more than probable that children would be better acquainted with the pretty harmless frog than they usually are; but as it is, the teacher will be able to elicit some facts with regard to general appearance, and mode of progression.

The body is broad, and short, and squat, and without a tail. The head is broad, triangular in shape, and very large in proportion to the size of the body. The *hind* limbs and feet are very long, and the toes — *five* in number — are webbed. The *four* toes of the fore-limbs resemble fingers, and are sometimes used as such. The skin, which is of a greenish-brown, yellow, or reddish color, is naked and covered with a slimy fluid. The eyes are large and prominent. Held in the hand the animal feels clammy, and cold.

Locomotion.— The children will readily associate the jumping mode of progression on land with the long hind legs; and the teacher should compare with other animals, such as the rabbit, which move in a somewhat similar fashion.

The webbed feet will suggest the swimming powers of the animal, and indicate the fact that it is its habit to live in the water as well as on the land. [If the teacher has a living specimen, the frog itself will demonstrate in a vessel of water how it swims.]

Breathing.— The teacher will call attention to the skeleton of the frog, showing that it has *no ribs*. Now in breathing we make use of our ribs to enlarge the cavity of the chest, and so admit the air through the nostrils or mouth into the lungs. [Show how this is done.] The frog, having no ribs, must get the air into its lungs in some other way, and this way is a very curious one. The frog simply swallows the air, as we swallow our food. Try and swallow with the mouth open. You cannot; neither can the frog; and to suffo-



SKELETON OF A FROG.
(a) Sternum, &c.

cate a frog, therefore, it is only necessary to keep its mouth open.

The frog closes the lips, and expands the cavity of the mouth, the air then enters through the nostrils. The mouth being full, the nostrils close like valves, and the upper portion of the

tube leading to the stomach closes also. Lastly the walls of the mouth contract, and the air is squeezed into the lungs. Watch the frog, it seems to be constantly swallowing; and so it is, it is swallowing air. But clearly this method of breathing does not take in a very large supply of air, and although it is probable that a considerable additional quantity is admitted through the moist skin, sufficient is not taken to make the blood as warm as ours.

A boy in running, breathes faster, takes in more air, and gets warmer. Birds breathe very fast, and have very warm bodies. Frogs breathe slowly and take in less air; their blood is colder than ours. They are called cold-blooded animals.

Feeding.— The food of the frog consists of living insects, snails, and worms; and as it swallows its prey whole, it needs no teeth with which to grind. It would be difficult, however, for a frog to hold a wriggling worm with the lips only, and so it is provided with a row of small teeth round the upper jaw. It is a curious sight to watch a frog in the act of swallowing a worm, pushing it into its mouth with the fingers of the forepaws, the worm all the while twisting and turning in its efforts to escape.

Insects, however, such as flies, are the favorite food of the frog. And how is it to capture prey swifter by far in motion than itself? It is provided with a special organ in its curious tongue. This fleshy organ has its root or base in front instead of at the back of the floor of the mouth like ours, and when at rest the tip of the tongue points backwards towards the throat. This arrangement permits the owner to protrude almost the whole of the tongue so that the tip extends far beyond the lips. There is also another curious provision: the tip is covered with a thick, sticky matter resembling glue. How does the frog use this curious "fly-catcher?" Watch it; a fly is within striking distance. You see a flash of something red from the frog's mouth, and the fly has disappeared. The action of the tongue, as it is shot out and withdrawn with the fly on its tip, is so rapid that it can hardly be followed.

Haunts.— Frogs cannot breathe in the water, except perhaps a little through the porous skin, neither is the fleshy tongue suitable for taking prey in the water. Hence frogs must spend the greater portion of their time on the land. Yet water is necessary to their existence. They require plenty of moisture to keep the skin in a moist state. Kept in a dry place the skin of the frog shrinks and dries, and becomes like stiff parchment, and the animal soon dies. Hence we usually find frogs near ponds and ditches, and for the same reason frogs appear to be more plentiful after storms, because the moisture tempts them from their hiding places.

There is another reason, too, why frogs frequent the neighborhood of water. At the bottom of the water they lay their eggs, and during the winter, when insects and slugs are not to be found, they sleep securely beneath the mud until the warm weather comes again.

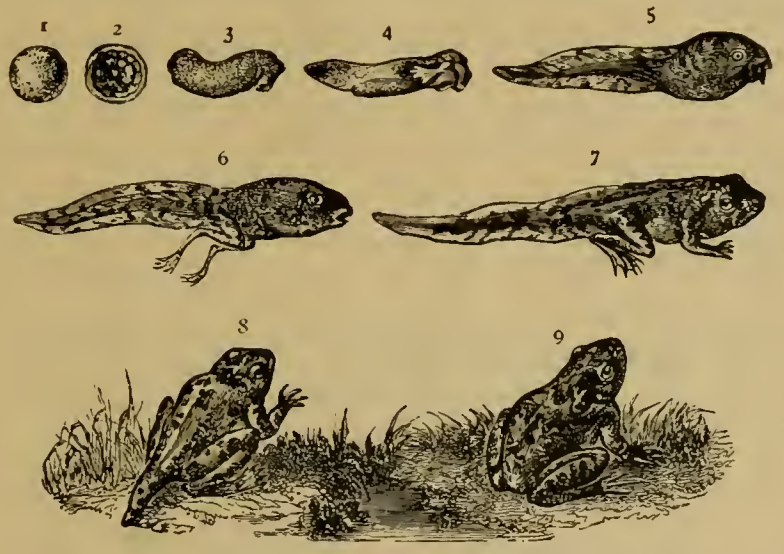
Uses.— Frogs are useful because they destroy large numbers of insects and slugs which feed on the vegetables and flowers. In some countries frogs are eaten, and are considered a dainty diet. In their turn, too, they serve as food for other animals, such as snakes, hedgehogs, etc.

(Living specimens of tadpoles in their various stages of developement will make this a very interesting lesson. They are easily kept some time in a warm corner. Failing the living specimens, pictures may be provided.)

From Egg to Tadpole.— Few animals can boast of so interesting a life-history as the frog. In the early spring, children in the country must have noticed in the ditches and ponds floating masses of jelly-like beads glued together. These are the eggs of the frog. In looking at the *spawn*, as these egg-masses are called, we do not see the eggs at all, or at most, only as tiny specks within the jelly-beads. The eggs, tiny as pins' heads, and covered with a glairy substance, are deposited at the bottom of the water. The slimy envelope absorbs water, and the mass rises to the

surface. The bead enclosing each head is now about the size of a pea. Toads, as well as frogs, lay their eggs in the water, but the toad arranges her eggs in double strings instead of masses.

Unlike birds, frogs take no further trouble about their eggs after being laid. In due time, however, they are hatched, and out of each there comes, not a frog, but a creature quite unlike a frog in every particular — a tadpole.



DEVELOPMENT OF THE FROG.

1. Egg of frog. 2. The egg fecundated and surrounded by jelly. 3. First state of the tadpole. 4. Appearance of the breathing-gills. 5. Their development. 6. Formation of the hind feet. 7. Formation of the fore feet and decay of the gills. 8. Development of the lungs and reduction of the tail. 9. The perfect frog.

The name, which very well describes the animal, is a contraction of *tailed-poll*; and *poll* being another name for *head*, it means *tailed-head*. And indeed the tadpole looks nothing but a head, with a flat tail attached thereto.

From Tadpole to Frog. — Now we must examine these tiny *heads* and *tails* as they dart and glide about in the water. In the first place we shall see on each side of the head little pink tufts. These are gills. They act like the gills of a fish, and enable the tadpole to breathe, as it were, through the water. [The teacher may show the gills of some common fish, as the herring.] It will be interesting to look at the tadpole of larger growth, to see what changes are brought about as they grow. But first the teacher will tell the children that rather below than in front of the head there is a mouth, and that this little mouth is surrounded by thin, horny plates sufficiently strong to enable the owner to nibble off the soft vegetables on which it feeds. [Compare this kind of feeding with that of the frog.]

If living specimens are provided, the children will be able to note the more evident changes. As the body increases in size the gills are enclosed in a little cavity; but they soon diminish in size, and the tail shortens. It is possible now on close inspection to find a pair of little knob-like projections just where the tail joins the body. These are the first signs of the legs. The legs are formed before the skin is broken. This tadpole has only one pair of legs, but an older tadpole shows another pair of knobs in front of the pair of legs. These will, later on, become the front pair of legs.

And so the growth and the changes go on for many weeks; the gills continue to diminish, and

the tail to shorten, until none of either is left. Meantime the body grows full and broad, the mouth gets round to the front, and broadens out, and the horny plates fall off. In addition to all this, no less interesting and important changes have been going on inside the body. In the place of gills *lungs* have been formed, so that the animal which before could breathe only in the water, can now breathe only in the air; and the *heart*, which in the tadpole had only *two* chambers like a fish, has now *three*, like other reptiles. In fact, externally and internally a complete *metamorphosis* has taken place. The tadpole, formed to live and move and have its being in the water, has become changed into a frog, fitted in every respect for its new life on the land.

After the change is complete it takes several years before the frog is full grown.

There is one other curious fact to record in the life-history of the frog. Like the snake, it periodically sheds its coat; but unlike the snake, the frog works the shed skin, with the help of its fingers, into a little ball, and, pushing it into its mouth, swallows it.